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NEW YORK, OCTOBER, 1889.

THE Massachusetts Institute of Technology has established a new course in Sanitary Engineering. As must be necessarily the case of a course of this kind, it is essentially one in Civil Engineering, but differs from the regular course in that subject in some particulars. There is a reduction in the time devoted to railroads and bridges and also to the subjects of machinery, motive power, and geology, the time thus gained being devoted practically to courses in chemistry and biology, while in the fourth year a course of instruction is also given in heating and ventilation. The object is to give the student such special training as shall fit him properly to interpret the results of sanitary chemistry, and to co-operate with chemists and biologists in their professional work.

THE City of New York, which has adhered very closely to stone pavements in spite of, or perhaps because of, some unfortunate experiments with other kinds of pavement in past years, is about to undertake the repaving of a number of streets with asphalt. It would hardly be fair to call this an experiment, since this material has been used so much in European and some American cities; but it is something new in New York.

The street pavements of New York, although in many cases good when first put down, are very generally in poor condition, owing to neglect of maintenance and to the constant tearing up and cutting to which they are subjected. The granite block pavement, although it has the drawbacks of noise and dirt, stands the very heavy wear and tear of the business streets better than anything else; but for the streets devoted mainly to residences, where the traffic is comparatively light, it would seem as if the asphalt pavement would be superior in many respects.

A VERY practical effort to give instruction in trades and to replace the apprentice system, which is now practically obsolete, is found in the New York Trade Schools which have been in operation for eight years past, and which are gradually increasing their extent and usefulness. These are not schools in which so-called manual training is merely a part of the course, or in which a few hours of the week are given up to instruction in hand-work while the rest of the time is occupied by books; but are schools in which young men are taught their trade by actual practical work. The departments now included in the school are bricklaying and masonry, carpentry, plumbing, painting, blacksmiths' work, and tailoring. Both day and evening classes are provided so that those boys who find it necessary to work during the day, can obtain instruction after regular working hours, and the school is thus far one of the most hopeful efforts that we know of to reach a solution of the problem as to how our young men shall learn a trade.

THE Young Men's Institute in New York, which is a branch of the Young Men's Christian Association, is making another practical effort to furnish instruction by the educational departments at its rooms. A number of evening classes are provided, among which is one in the theory and practice of Steam Engineering, which is taught by a practical engineer, and is intended for engineers, firemen, and apprentices. This class opens at the building of the Institute, No. 222 Bowery, early in October, and continues throughout the winter and spring.

SHORT ocean trips continue to be the order, and the *City of Paris* on August 28 completed the best run from Queenstown to New York which has yet been made. The actual time from Queenstown to Sandy Hook was 5 days 19 hours and 18 minutes, and the total distance run was 2,788 miles. The best day's run made during the voyage was 509 miles, being an average of 21.2 miles per hour.

A PETITION carrying some 10,000 signatures has been sent to the Interstate Commerce Commission requesting that body to urge upon Congress the necessity of national legislation to bring about the adoption of automatic brakes and couplers for freight cars throughout the country. The signers, it is stated in the petition, are either now employed on railroads as brakemen, or have been so employed for a sufficient length of time to understand well the duties and dangers of the position. They present a statement of the number of trainmen who are yearly killed in coupling cars, and represent to the Commission that these figures are sufficient to authorize them to consider the question. The Commission has as yet taken no action in the case.

ON another page will be found an account of the experience of the Swiss railroads in the substitution of iron and steel for wooden ties. The results have been so satisfactory to the Swiss engineers that the question is no longer regarded as in an experimental stage, and metal ties have been adopted as the standard for all renewals on several of the Swiss lines.

In this connection it may be noted that the Permanent Commission of the International Railroad Congress in Europe has recommended that a uniform system of trials of metal ties be adopted by all the railroads connected with the Congress which are in position to undertake such a work. The plan recommended is to take trial sections of 500 or 1,000 meters; one to be laid with metal and the other with new wooden ties, under conditions as nearly alike as possible in relation to the sub-soil, dryness, drainage, etc., and to note carefully the cost of maintaining

each section through a series of several years. The results would no doubt give some valuable points of comparison, but the ultimate decision after all must depend upon the life of the iron or steel tie, and that can only be determined after a long series of years. From experience already obtained, it seems probable that the metal tie will outlast several wooden ones, although the long life of the wooden ties which had been subjected to some of the different processes for preserving timber on the Austrian State railroads still leaves room for some doubt on this point. At any rate, the results of the experiments recommended will be of much value and interest to engineers in this country as well as in Europe.

THE *Engineer* says that Mr. Webb, of the London & Northwestern Railway, has designed and constructed a locomotive with three cylinders, which are respectively 14 in., 14in. and 20in. in diameter, with 24-in. stroke. This engine, our contemporary says, is not a compound engine, but a continuous-expansion engine. Steam from the boiler can be introduced directly into all three of the cylinders whenever a special tractive effort is needed, as in starting a heavy train or in ascending a steep grade. In ordinary work the steam can be and is expanded through all three of the cylinders. The engine is, of course, experimental, but it is stated that the results so far obtained are satisfactory. We do not understand, however, that the question is settled as yet, but that the experiments are to be continued.

THE new cruiser *Baltimore* made a remarkable record on her official trial trip, her speed averaging over 19 knots an hour on a four-hours' run, while at times she made over 20 knots. This places the new ship very high in the list of fast war-ships, and is a most creditable result for her builders and designers.

The *Philadelphia*, which was launched last month, will, it is hoped, do as well. She nearly resembles the *Baltimore* in design.

The recent trials of the *Yorktown* have also shown her to be a very serviceable vessel. These trials were made to determine her ability in manœuvring, and proved her to be a very quick and easily handled vessel.

On the whole, the new gunboats and cruisers promise to be ships of which no navy need be ashamed.

ANOTHER water transportation line, which has been in operation for a good many years, seems likely to be abandoned. The Pennsylvania Canal was so much damaged by the floods of last summer that it has been finally decided to abandon the work on a considerable section of it and to make no attempt to re-open it. Some 40 miles of the Canal will be retained in use, but for 90 miles, from Huntingdon to the Susquehanna River, it will probably be abandoned. This Canal, which was originally built by the State, has been for a number of years past owned by the Pennsylvania Railroad Company, and has been used chiefly for carrying coal, logs, and similar low-priced freight.

ATTENTION is called to the valuable diagram of Functions of Railroad Turnouts which accompanies this number of the JOURNAL as an inset, facing page 459. The directions and explanations accompanying the diagram will, it is believed, enable all engineers to apply it without difficulty, and the advantages of presenting these functions in a graphic form will be quickly appreciated.

FIRE-BRICK LINED FIRE-BOXES FOR LOCOMOTIVES.

THE most costly and the most troublesome and expensive part of a locomotive to make and to maintain is the fire-box. The inside plates are liable to crack, to corrode, and to burn out. The riveted seams, both inside and outside, often leak, and the outside plates are frequently corroded. Every locomotive superintendent and master mechanic is in constant fear of broken stay-bolts; crown-bars are heavy, expensive, and often a cause of trouble, and the braces and stays above the crown-bars are a source of constant anxiety. If we could dispense with all of these we would get rid of the most troublesome and costly parts of a locomotive.

A method of doing this has been proposed and experimented with, but for some reason—or, more probably, without reason—has not been favorably entertained by those who would be benefited most by such a change. As long ago as 1878 Mr. Stefan Verderber, Inspector-in-Chief of Hungarian State Railroads, took this subject up, and in a paper which he wrote on the subject said:

On most of the Hungarian Government railroads the feed-water is very bad, and forms large quantities of sediment; consequently the boilers of this company need more frequent and extensive repairs, particularly in their fire-boxes, than those of other companies having at their disposal a better kind of feed water. Under these circumstances I endeavored, as many other engineers have done before, to remove, or at least to lessen, this inconvenience caused by the failure of fire-boxes. Examining the investigations of others, I became convinced that only by abolishing the water-surrounded fire-boxes would there be a possibility of effecting a real remedy, and, in consequence, I tried to solve this problem, and contemplated the employment of a cylindrical tubular boiler combined with a fore-fire of fire-proof material for receiving the fire-grate.

The fact that the fire-box, with a moderate application of the blast pipe, produces nearly 50 per cent. of the whole steam produced by the boiler, has led to the false notion that the cylindrical part of the boiler is not capable of producing the necessary quantity of steam without the aid of the fire-box. My observations, however, led me to another conclusion. It first struck me why the heating surface of the tubular boiler performs so little work in comparison with the fire-box. The reason for the small capability of the boiler tubes in comparison with the fire-box are the following:

1. The burning gases pass only through a part of the tubes, consequently the other part is either quite or partly out of action.

2. The temperature of the burning gases diminishes during their progressive movement in the tubes, and therefore less heat will enter the boiler toward the smoke-box end.

3. Finally, and principally, the deficient heating capability of the boiler-tubes is accounted for by the fact that nearly 50 per cent. of the available heat is absorbed by the fire-box before the burning gases enter the boiler-tubes, in consequence of which they cannot possibly take up more heat.

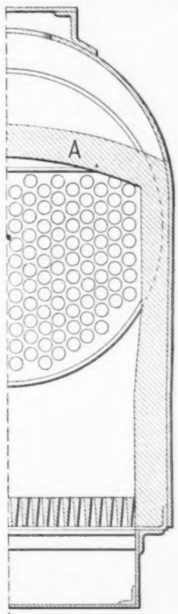
There is no reason at all why the tubes should—at equal temperature and density of the burning gases—evaporate less water per square foot of surface than the fire-box; I had, therefore, no doubt whatever that, if the burning gases at their original temperature could be led into the boiler-tubes, they would receive the whole available heat, and consequently the tubular boiler would do as much work without the fire-box as with it—that is to say, *the fire-box as a steam*-generating part of the boiler *is superfluous.*

This latter conclusion of Mr. Verderber has been received by locomotive men with the greatest incredulity. They say—what was admitted by him—that about half of the steam produced by a boiler is generated by the fire-box, and therefore if you take that away you dispense with the best part of your heating surface. In reply to this it may be said that the fire-box is the hottest part of the boiler, and therefore, quite naturally, the surfaces immediately around the fire absorb more heat than is communicated to the water through the heating surface in the

tubes. If one-half of the heat is communicated to the water around the fire-box, it is absurd to expect that there will then be as much left to be conducted by the tubes; but if the heat is not extracted from the fire in the fire-box it will enter the tubes, and, as Mr. Verderber remarked,

Transverse Section.

Fig. 2.



Longitudinal Section.

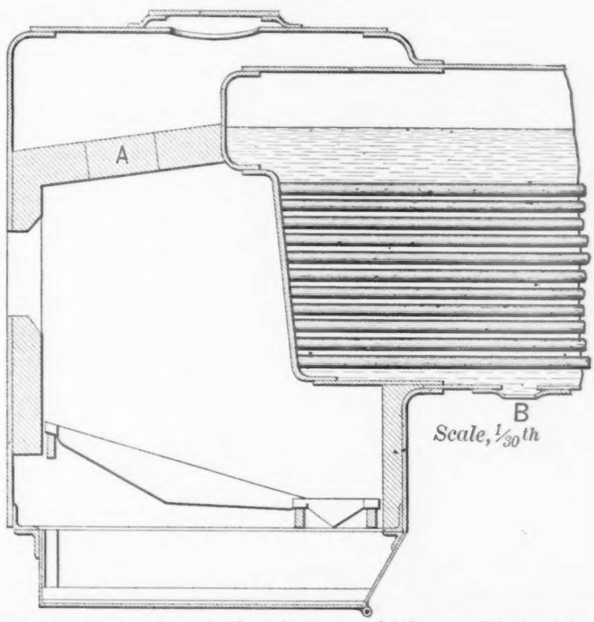


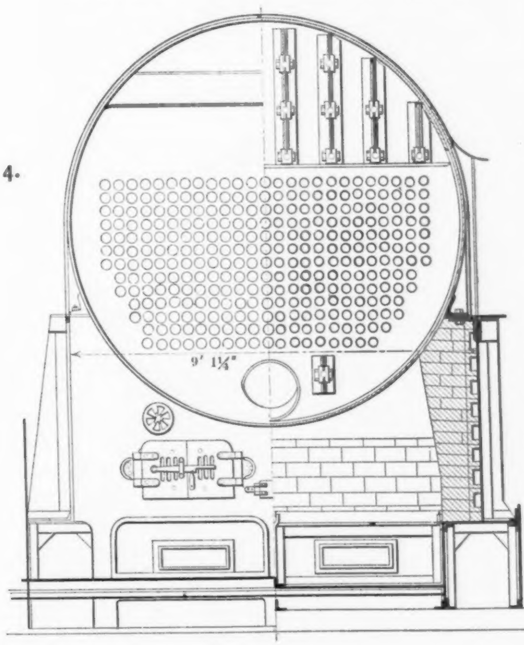
Fig. 1.

"there is no reason at all why the tubes should—at equal temperature and density of the burning gases—evaporate less water per square foot of surface than the fire-box."

Having satisfied himself that the tubes would absorb the heat if it was not first abstracted in the fire-box, he took an ordinary locomotive, with water-spaces around the fire-box, and lined it with plates covered with fire-clay, leaving

End View. *Transverse Section.*

Fig. 4.



Longitudinal Section.

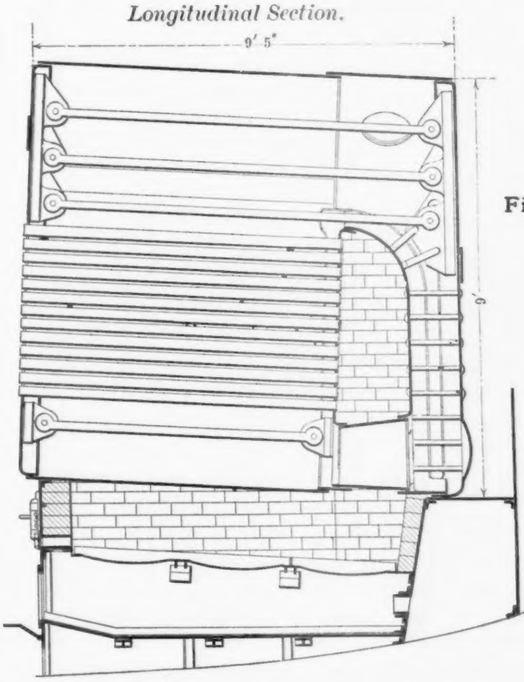


Fig. 3.

an air space of about 2½ in. from the fire-box plates, so that no heat could be conducted to them. It was found that with this arrangement a given weight of coal evaporated as much water as was evaporated before the change was made.

He then took an old boiler the fire-box of which required renewal and removed the inside plates, stay-bolts, etc., and put a new tube-plate in the back end, and lined the outside shell of the fire-box with plates covered with fire-clay, leaving a space between these plates and the outer shell as before, which was filled with mineral wool. This engine gave as good evaporative results after the change was made as it did before, but some trouble was experienced in keeping the tubes—which were brass—tight in the copper tube-sheet.

Being satisfied of the evaporative capabilities of such a boiler, Mr. Verderber then had a boiler, shown in figs. 1 and 2, constructed. In this arrangement he says, "The cylindrical part of the tubular boiler reaches into the fire-room, as shown in fig. 2; the tube-plate is composed of two parts, and has a play for expansion both in the vertical and horizontal direction." This fire-box at first was

lined with the plate casing covered with fire-clay, but afterward a common fire-brick lining, with arched roof, was made, as shown in figs. 1 and 2, of which it was said, in the paper already quoted from, that, at the time of writing, it had worked about five months and had worn well. A careful set of experiments were made, which showed that this boiler gave practically as good evaporative results as boilers of the ordinary type.

There are now a number of steamboats and steamships which have fire-brick lined fire-boxes which have been in regular use for a number of years. The steamboat *Nashua*, of the Providence & Stonington line of steamers, running to New York, and the *Louisiana*, of the Old Dominion line, both have fire-boxes of this kind. The United States twin-screw steam cruiser *Chicago* also has boilers of this kind, represented by figs. 3 and 4.

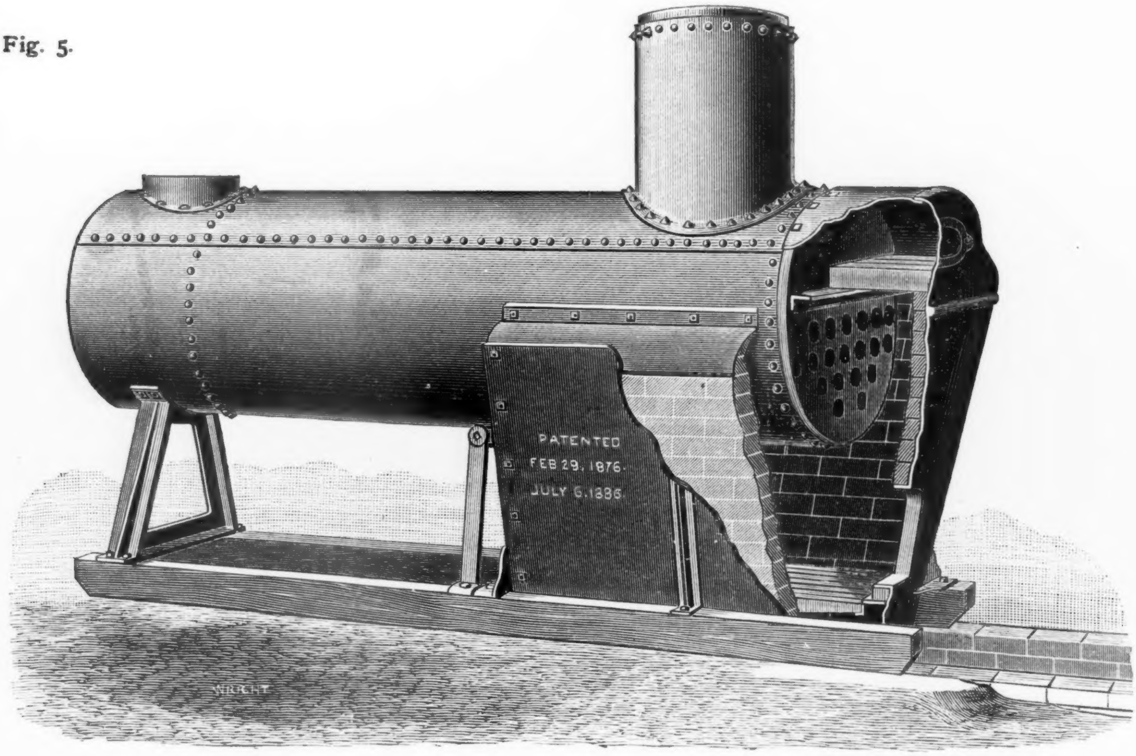
The purpose of this article is to show the entire practicability of using fire-brick lined fire-boxes on locomotives, and with that end in view to cite examples of such use under various circumstances and conditions. In doing this it seems hardly necessary to refer to the common form of brick fire-box used for stationary boilers. Thousands of these are in use in all parts of the world, and no one ever objects to their use, or even hints that they are not economical. Although the sides of such fire-boxes are of no service in *transmitting* heat to the water, it is equally true that very little or no heat is *conducted* through the walls of such furnaces and wasted. The same thing is true of the locomotive and marine fire-boxes which have been illustrated.

Fig. 5 represents a perspective view of a portable boiler which was patented by Walter J. F. Liddell, of Charlotte, N. C., and is manufactured by the Liddell Company of that place. In a trade circular issued by that Company, they say of ordinary portable boilers—and their observations are equally true of locomotive boilers—that:

The weakest and most exposed parts are the crown-sheet and furnace sides. They require to be heavily stayed to resist the pressure; and although most exposed to the fire, are yet the parts most liable to injury caused by low water or deposits of sediment. The first part exposed by low water is the crown-sheet, which is at all times subjected to the greatest heat, and yet has always the least water to protect it The sides of the furnace are ready receptacles for the deposit of mud and all impurities of the water, while the numerous stay-bolts required to strengthen them make them the most difficult parts of the boiler to keep clean. As a result *the furnace* of the portable boiler *is the great source of danger* and expense for repairs.

In the Liddell boiler these objections are removed, while at the same time the elements of portability and convenience are fully retained. In this boiler we have no flat crown-sheet, no furnace sides to fill with mud and burn out, no stay-bolts, and *but one seam* exposed to the fire. Instead of having *less* water over the crown sheet than in any other part of the boiler, we here have *more*, and the effect of low water is not to expose the crown-sheet, but the upper row of tubes, which may cause a leak but not an explosion, and will not endanger life. The fire-brick lining in the sides, when worn out, is easily replaced at a trifling expense, and the great cost of repairs, to which the ordinary portable boiler is subject, is saved.

Fig. 5.



The Superintendent of that Company says that boilers of this kind have very much greater steaming capacity than those of the same size with water-spaces, and that a greater economy of fuel results on account of the higher temperature which is maintained by the fire-brick.

Three different types of this boiler have been used, and there has been some difficulty in holding the brick in position, the greatest trouble has been from breaking the brick in the act of throwing wood into the fire-box. With the present form, having inclined sides and ends, the bricks and the castings last a reasonable time.

The boiler has been in use over ten years, the Liddell Company have built about 200 of them, and the Erie City Iron Works has made over 1,000 of them. The President of the latter Company says: "We have no trouble about getting our fire-brick to stand, as we have them made to pattern, and have very good means of holding them in place."

From the engravings it will be seen that the sides and ends of the fire-box are flaring or inclined. This method of construction has been adopted, the inventor says, "so that the fire-brick lining will be held against displacement by its own gravity, which tends to hold the bricks firmly in place against the flaring sides or wall of the fire-box." The flaring sides form the principal element of the patent.

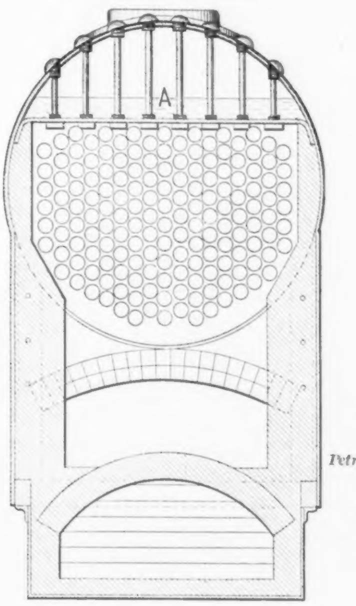
In a paper on The Use of Petroleum Refuse as Fuel in Locomotive Engines, by Mr. Thomas Urquhart, Locomotive Superintendent of the Grazi-Tsaritsin Railroad of Russia, which was read before the Institution of Mechanical Engineers in London last January, he says that, having occasion to renew some worn-out copper fire-boxes, he adopted a modification of the Verderber furnace for two locomotives, goods and passenger, fired with petroleum refuse, which have now been running over two years. One of these boilers is represented by figs. 6 and 7. He says further, that "from his own observations with these two locomotives he would have no hesitation in using the plan for all his boilers, as there is much about it which, in his opinion, recommends it for firing with liquid fuel." The modification which he refers to consists in replacing the brick arch, which forms the roof, *A A*, figs. 1 and 2, of the Verderber furnace by a crown-sheet *A A*, figs. 6 and 7. The author says:

This not only increases the water-space of the boiler and adds some very useful heating surface, but also appears to him to be indispensable for the two following reasons: First, there could be no guarantee that the brick roof of the Verderber furnace would not come down some time while running, and so bring the train to a premature stop on the line. Secondly, the crown-sheet, having water on the top of it, carries the water level back again to the original back plate of the fire-box, where all the water-gauge fittings are ordinarily mounted.

The consumption of fuel per train-mile with these fire-brick furnaces *is no more than with ordinary locomotive boilers having internal fire-boxes*; and the author is indeed disposed to conclude that *there is a decided economy in their favor on this score.* In comparison with engines of the same class, but with ordinary fire-boxes, the mean of several trials made with the Verderber fire-boxes gave an economy of 8 per cent. in the passenger engine and of 4 per cent. in the goods engine, in saving of fuel per train-mile. But the greatest advantages of the fire-brick furnaces are the reduction in first cost and cost of maintenance, and *the shorter time the engines have to stand in the repairing shop*, inasmuch as the boiler repairs amount simply to changing the tubes and renewing the brick lining of the furnace. Even with coal, with which Mr. Verderber's experiments were made, the evaporation attained per pound of fuel was equal to that with the ordinary fire-box. The object of his plan, however, was not to effect economy in fuel, but rather to obviate the incessant damage to fire-boxes and the consequent stoppages, which were caused by rapid incrustation in the water-spaces surrounding the fire-box, from the very bad feed-water he had to contend with; and this object he fully attained. The six-coupled goods locomotive, of which the furnace is shown in figs. 6, 7 and 8, was altered in August, 1885, and has been running ever since; it had previously, when burning coal, 151 tubes of $2\frac{1}{4}$ in. diameter and a total heating surface of 1,248 square feet, including 82 square feet in the fire-box; it has now 157 tubes of the same diameter, and 2 ft. $1\frac{1}{2}$ in. longer, which with 13 square feet in the fire-box roof give a total heating surface of 1,410 square feet, or an increase of 162 square feet. As shown in fig. 8, the fire-brick lining is secured to the fire-box shell by means

Transverse Section.

Fig. 7.



Longitudinal Section.

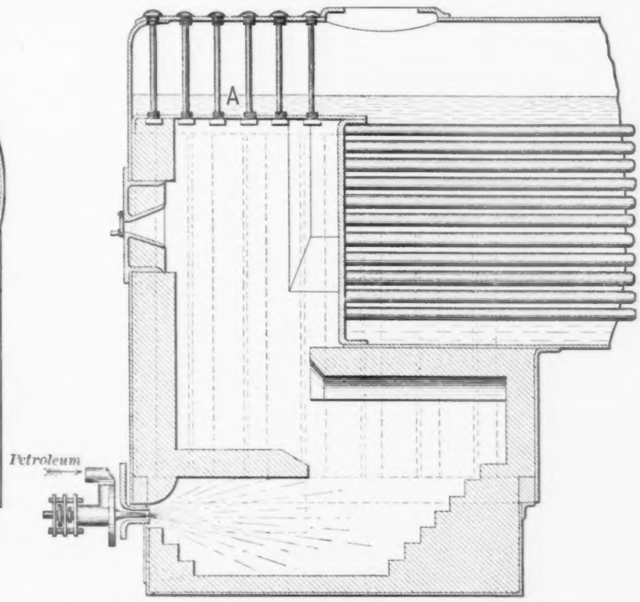
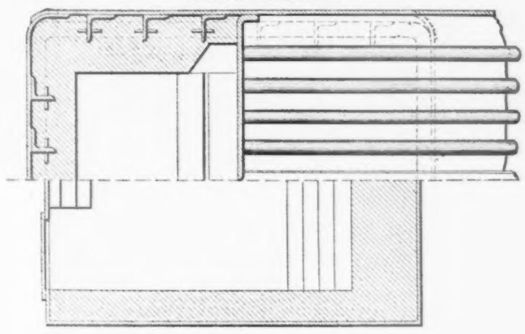


Fig. 6.

Sectional Plan.

Fig. 8.



Scale, 1/30 th

of vertical angle-irons riveted to the shell plates and imbedded in the fire-brick.

In the discussion of his paper Mr. Urquhart said that "The cost of maintenance is less, and *the loss of time from the engine standing in the shops for repair is less than half what it would be in the case of an ordinary fire-box.*"

The fear has been expressed that the outside of a fire-box lined with fire-brick would be much hotter than one surrounded with water. With reference to this Mr. Verderber reported that he cased the fire-box with plate, and the space of about 2 in. was stuffed with slag-wool; consequently the temperature of the casing-plate is much lower than that of a common locomotive. He reported that "one may safely put his hand upon the casing-plate of the locomotive while working, which one could certainly not do on other locomotives." He said further: "My apprehension that the brick-work would suffer by the shaking of the engine has proved unfounded. . . . It will be of interest to technical men to know that the fire-brick lining of the combustion chamber stands perfectly well against the shaking of the locomotive as well as against the temperature of the fire-box."

With this evidence before us it seems quite safe to conclude:

1. That with a slight increase in the tube-heating surface a locomotive boiler, with a fire-brick lined fire-box and without water-spaces around the fire, will generate as much steam and do it as economically as an ordinary boiler will.

2. That such lining can be made to stand a reasonable length of service, and by lagging the outside it is not as hot as an ordinary boiler.

3. That the first cost and cost of maintenance of a fire-box of this kind, is materially less than that of one of the ordinary kind with water-spaces—that it is safer, will give better combustion, and that much less time is lost in making repairs than is required with the boilers now in use.

The advantages which would result from the use of such fire-boxes would be very great. It would reduce the locomotive boiler to a simple cylinder with tubes in it, and without any other bracing than that required for the upper part of the tube-plates. This would be the simplest and cheapest form of boiler to make. There would be no flanging of plates excepting for the edges of the tube-plates and the base of the dome. Stay-bolts would become a thing of the past, cracked and leaky fire-boxes would cease to worry boiler makers, expensive plates for them would no longer be needed, and crown-bars and their braces could be abolished.

We have been at some pains to collect all the testimony bearing on this subject, which is within reach, with the hope that some of the locomotive superintendents of the country would have sufficient faith in the new departure, and enough enterprise to give it a thorough test. The evidence which has been cited places it entirely beyond the stage of mere speculation and makes the success of the scheme reasonably certain. Who will be the first to try it in this country?

NEW PUBLICATIONS.

NAVAL MOBILIZATION AND IMPROVEMENT IN MATERIAL: BEING NO. VIII OF THE GENERAL INFORMATION SERIES, NAVAL INTELLIGENCE. BUREAU OF NAVIGATION, NAVY DEPARTMENT: LIEUTENANT R. P. RODGERS, U. S. N., CHIEF INTELLIGENCE OFFICER. Washington; Government Printing Office.

We have before referred to this very excellent series issued by the Naval Intelligence Office, the object of which is to give a record of naval progress and of new inventions and improvements; primarily, of course, for the use of naval officers, but incidentally very interesting to engineers and other civilians.

The present issue includes papers on Naval Mobilization; the Naval Manœuvres of 1888; Armor; Gun Development and Naval Gunnery; Fish-torpedoes; Propulsion; Electricity for Naval Purposes; and the Resources of the United States for the Production of War Material.

There are also a number of shorter notes on ships, machinery, ordnance, armor, torpedoes, torpedo-boats, etc.

Probably the most interesting chapters are the one which reviews the great changes which have taken place in naval opinion concerning the distribution of armor on war-ships, and that which describes the great development which the resources of the United States for the production of war material have received during the last few years. This development has been really surprising, and goes far to prove how readily our manufacturers will respond when a demand arises.

How great a part electricity is coming to play on our war-ships, as well as everywhere else, is shown in the chapter on that subject, some extracts from which will be found on another page.

A BIBLIOGRAPHY OF GEODESY: BY PROFESSOR J. HOWARD GORE, PH.D.: BEING APPENDIX NO. 16 TO THE REPORT OF THE UNITED STATES COAST AND GEODETIC SURVEY FOR 1887. Washington; Government Printing Office.

As with the somewhat similar German book of Professor Boersch, which was noticed in the JOURNAL for September, this work impresses one with an idea of the great volume of the literature which has been published on this subject. There are 195 large pages, with an average of about 25 titles to the page, so that the reader can easily figure out for himself how many books are included in the list.

The plan adopted in this index is to use only one alphabet, in which will be found subjects, abbreviations, and authors. The title of the book is given in the language in which it is published. Wherever possible—and especially in the case of rare books—the name of the owner, or of the library where it may be consulted, is given; this will be a great convenience to scholars who wish to find such books, or to procure material on the subject.

The amount of work involved in preparing a book of this kind can only be appreciated by those who have undertaken similar tasks. It is enormous, and so many thanks are due to those who have the courage and patience to begin and carry it through, that any criticism must seem ungracious. It does seem, however, as if the value of this index might have been increased by the use of more double titles or cross-indexing. The saving of labor to a searcher after knowledge would have been so great, that it would have fully warranted the required addition to the size of the book. This is a comparatively small matter, however;

setting it aside, Professor Gore deserves the thanks of all students of Geodesy for his work, which has a permanent value. The Coast Survey has done well to make it a part of the valuable series which it issues.

Report on European Dock-yards: by Naval Constructor Philip Hichborn, U. S. N. Washington; Government Printing Office.

This report is the result of a tour of observation made by Naval Constructor Hichborn, under orders from the Navy Department, some time ago. The chief object of the tour was to collect information with regard to improvements in naval architecture, particularly with relation to the construction of steel war vessels.

The report contains sections or chapters on National Dock-yards; Details, Fitting and Equipment of Naval Vessels; Torpedo Boats; Ship-yard Appliances and Tools; British Private Yards; Management of Work and Employés; Iron and Steel Works; and Docks. The descriptions of a number of the more important docks and shipyards are illustrated by plans and other engravings; and there are also a number of engravings of ships and of tools and other appliances used in ship-building. The ship plans include the English *Rodney*, *Colossus*, and *Imperieuse;* the French *Sfax* and *Vauban;* the Spanish *Riachuelo*, and other famous battle-ships and cruisers.

Not the least interesting parts of the book are the chapters on those British Private Yards where so many warships have been built for all nations, and on the Management of Work and Employés, a subject of interest to builders everywhere.

Mr. Hichborn's report must be considered a valuable and interesting contribution to naval literature.

General Specifications for Highway Bridges of Iron and Steel: Second Edition, Revised and Enlarged: by J. A. L. Waddell, Consulting Bridge Engineer. Kansas City, Mo.; published for the Author (price 25 cents).

Mr. Waddell's pamphlet on Highway Bridges attracted a great deal of attention when it first appeared, and was the means of starting a discussion which promises to do much toward raising the general standard of those structures. In the present edition there is much new matter, including the Preface; part of Chapter III, on Bridge Lettings; part of Chapter IV, on the Building of Bridges; and an additional Chapter (IX), giving discussions of the question by engineers. Some changes have been made in the proposed standard specifications, but none of importance.

That a reform in the methods of letting contracts for highway bridges is much needed there can be no doubt. Under the system now obtaining many bridge-builders of repute do not care to enter into such competitions, and a large share of the work has gone to men whose only aim is to make as much money as possible, without regard to the design and construction of the work, which may be as poor as can possibly pass muster. The great trouble has been that in most cases the final acceptance of the work rests with men who know nothing whatever of bridge-building. To correct this abuse and to establish some system of inspection, is Mr. Waddell's object, and his pamphlet has certainly served to draw attention to the subject. This is all that any author can hope to do, after all, and so in this case the book must be considered a successful one. It may also be said that it contains much matter of value to the engineer.

Some Difficulties Encountered in the Operation of Pumps, as Met by the Positive Piston Pump: by Josiah Dow. Philadelphia; reprinted from the *Journal* of the Franklin Institute.

This is a reprint of a paper read before the Franklin Institute, the object of which is to show the difficulties inherent in the working of all reciprocating pumps. Mr. Dow makes a strong argument in favor of the advantages of continuous working in handling a column of water, as opposed to reciprocating action, and he sets forth the shocks to which the ordinary plunger or piston pump is exposed in a striking way.

Mr. Dow has had much experience in this line, and is the inventor of what he calls a "positive piston" pump, which has met with much success, and has worked very well on the lines which he has laid down in this paper.

Report of the Proceedings of the Twenty-second Annual Convention of the American Railway Master Mechanics' Association, held at Niagara Falls, N. Y., June 18, 19, and 20, 1889: Angus Sinclair, Secretary. Chicago; printed for the Association.

An usual, the *Proceedings* of the Master Mechanics' Association appear with commendable promptitude, Secretary Sinclair's experience as an editor having taught him the advantages of placing the yearly report of the Convention before its public as soon as possible.

The volume contains about the usual amount of matter, and includes this year two or three reports of especial interest. Those on Thickness of Tires and Metal for Tires; on Driver Brakes, and on Driving and Engine Truck Boxes, called out most attention and discussion at the Convention, and will doubtless have the same effect outside of it.

Manual of the Railroads of the United States: by Henry V. Poor. Twenty-second Annual Number, 1889. New York; H. V. & H. W. Poor (Price, $5).

In the September number of the Journal, editorial mention was made of the valuable introduction to this publication, the advance sheets of which had been received. The book was not then delivered, but its receipt is now acknowledged.

No more difficult task is laid upon the reviewer than that which calls upon him to speak of a publication like *Poor's Manual*. To any one who knows the great difficulties which lie in the way of compiling statistics necessarily drawn from sources so various, and often so difficult to obtain, since they are furnished voluntarily, it need not be said that the completeness with which the *Manual* gives the figures published calls for the highest commendation.

Bearing this in mind, criticism seems ungracious when it is not laudatory; but, at the risk of seeming to be ungracious, such criticism must be made.

As the only authority on which those who desire the information given in the *Manual* can rely—at least for a very large part of it—the thanks of the public are due; but

while those who consult the *Manual* may fully appreciate its many good features, they have the right to ask the publishers not to rest upon their past achievements, but to remember that there is nothing so deceptive as figures based upon previous reports.

It is very easy to arrive at wrong conclusions from figures so obtained, and the fact that the *Manual* is so high an authority should warn the publishers to avoid falling into this error, which will eventually become fatal to their reputation if not corrected.

If space permitted, it would be pleasant to point out the features of the book which call for unqualified praise. The maps will be appreciated. The arrangement of the lists of officers of railroads is acceptable, and the information in the appendix is valuable, though the heading of "Foreign Railways" over a list which only includes the railroads of Central and South America is somewhat misleading until the sub-title is consulted.

BOOKS RECEIVED.

INTELLIGENCE REPORT OF THE PANAMA CANAL: BY LIEUTENANT CHARLES C. ROGERS, U.S.N., INTELLIGENCE OFFICER U. S. STEAMER "GALENA." Washington; Government Printing Office.

PROCEEDINGS OF THE SEVENTEENTH MEETING OF THE ASSOCIATION OF NORTH AMERICAN RAILROAD SUPERINTENDENTS, HELD AT NEW YORK, April 8, 1889: C. A. HAMMOND, SECRETARY. Boston; issued by the Association.

JOURNAL OF THE NEW ENGLAND WATER-WORKS ASSOCIATION, SEPTEMBER, 1889: F. H. PARKER, ALBERT S. GLOVER, EDITORS. West Newton, Mass.; published by the Association. This number of the *Journal* contains the proceedings of the Annual Convention at Fall River in June, with the papers then read and the discussions on them.

PUMPING MACHINERY, ANCIENT AND MODERN: BY J. F. HOLLOWAY. New York; issued by the Author. This is a lecture delivered before the Class of Mechanical Engineering of Sibley College, Cornell University, in April last.

UNIVERSITY OF VIRGINIA, SCIENTIFIC AND ENGINEERING DEPARTMENTS: ANNOUNCEMENTS, 1889–1890. Charlottesville, Va.; issued by the University. The Scientific Department of the University has received a great development in recent years, as is shown by the announcements contained in the present circular.

OCCASIONAL PAPERS OF THE INSTITUTION OF CIVIL ENGINEERS. London, England; published by the Institution. The present installment of these papers includes four, all of value: Experiments on a Steam Engine, by Bryan Donkin, Jr.; Investigation of the Heat Expenditure in Steam Engines, by Professor Dwelshauvers-Dery; Armor for Ships, by Sir Nathaniel Barnaby; the Treatment of Steel by Hydraulic Pressure, by William Henry Greenwood. They also include an abstract of the discussion on Messrs. Greenwood's and Barnaby's papers.

REPORTS OF THE CONSULS OF THE UNITED STATES TO THE STATE DEPARTMENT: NOS. 106 AND 106½, JULY, 1889. Washington; Government Printing Office. This series, issued by the State Department, contains many valuable papers and reports, some of them worthy of especial attention.

GEARING: LIST OF GEARING PULLEYS, SHEAVES, ETC. Baltimore, Md.; the Robert Poole & Son Company, Engineers and Machinists. The size of this catalogue and the length of the lists of gear wheels of all descriptions give some idea of the great number of patterns owned and the extent of the business done by a long-established concern like the publishers of this catalogue.

A COMPILATION OF RESOLUTIONS, STATISTICS AND USEFUL INFORMATION PERTINENT TO THE MEXICAN SILVER LEAD ORE QUESTION. El Paso, Tex.; published by the Board of Trade, the Common Council, and the Southwestern Mining Association.

MACHINE TOOLS: ILLUSTRATED CATALOGUE OF LATHES, PLANERS, DRILLING MACHINES, SHAPERS, GEAR-CUTTERS, ETC. New Haven, Conn.; the New Haven Manufacturing Company.

PORTABLE ROPE HOISTING MACHINES: CATALOGUE AND DESCRIPTION. Philadelphia; the Energy Manufacturing Company.

MACHINERY FOR WIRE-WORKERS AND HARDWARE MANUFACTURERS: CATALOGUE AND DESCRIPTION. New Haven, Conn.; John Adt & Son.

UPRIGHT POWER HAMMER FOR DROP-FORGINGS, ETC.: CATALOGUE AND DESCRIPTION. New Haven, Conn.; the Belden Machine Company.

ILLUSTRATED CATALOGUE OF WOOD-WORKING MACHINERY. Norwich, Conn., and New York; issued by C. B. Rogers & Company. It is very fully illustrated, and shows a large assortment of wood-working tools manufactured by the firm, including every kind of tool needed in a car shop, or any factory where wood is used.

DUPLEX PUMPS FOR FEEDING STEAM BOILERS. Philadelphia; issued by the Barr Pumping Engine Company.

CAROLINA OIL & CREOSOTE COMPANY, CARBONIZED AND CREOSOTED TIMBER AND CROSS-TIES: DESCRIPTION OF FACTORY AND PROCESSES. Wilmington, N. C.; issued by the Company.

TIME-CHECKING MACHINES MANUFACTURED AND PATENTED BY LLEWELLIN'S MACHINE COMPANY, BRISTOL, ENGLAND: CATALOGUE AND DESCRIPTION. New York; issued by E. P. Spaulding & Company, Agents, 17 William Street.

ABOUT BOOKS AND PERIODICALS.

THE JOURNAL of the Military Service Institution for September contains articles on the Defenses of Puget Sound, by General John Gibbon; Hasty Intrenchments for Infantry, by Lieutenant W. A. Shunk; Desertion in the Army, by Lieutenant W. D. McAnaney; Artillery Organization, by Lieutenant E. M. Weaver; the West Point Cadet Uniform, by Assistant Surgeon James E. Pilcher. There are also the usual translations, etc., including a continuation of Prince Hohenlohe's Letters on Infantry and Artillery, and much miscellaneous matter of interest, besides a summary of the discussions of the Institute.

In HARPER'S WEEKLY for September 14 there is an interesting article on the Electric Motor Applied to Street Cars, by Henry Loomis Nelson. It is illustrated, and is intended to show what has been done in this direction and what has been proposed. The storage-battery and overhead-conductor systems are both described and illustrated.

The electrical articles in SCRIBNER'S MAGAZINE for October are on Electricity in Naval Warfare, by Lieutenant W. S. Hughes, U.S.N., and Electricity in Land Warfare, by Lieutenant John Millis, U.S.A. Professor N. G. Shaler has an article on the Improvement of Common Roads, a subject which is just now attracting much attention.

The NORTHWESTERN MECHANIC, a monthly recently started in Minneapolis, Minn., has passed under the editorial management of Mr. James F. Hobart, who is well known as a writer for the technical press. It is a bright and independent paper, and seems determined to earn a place, and to deserve the prosperity which we hope it will secure.

HYDROGRAPHY AND HYDROGRAPHIC SURVEYS.

By Lieutenant Henry H. Barroll, U.S.N.

(*Continued from page* 413.)

VIII.—THE HYDROGRAPHIC OFFICE AND THE NAVIGATOR.

When Lieutenant Maury first began the collection of meteorological data, he enlisted the assistance of the Merchant Marine of our own as well as foreign nations. Log-books were furnished them, in which were entered the records of the observations made during the entire cruise, and these books, upon the vessel's return, were sent to Washington, where the records were collated, and those observations which corresponded in locality were gathered together. In this way much more accuracy was to be obtained than by trusting to any single account.

The system of arranging the data collected is briefly as follows: The whole water surface of the globe is divided into squares of five degrees of longitude by five degrees of latitude, and each of these squares so formed has a distinctive number assigned to it. That portion of a ship's time that is consumed in passing through any particular square, and the observation for wind, temperature, etc., taken during this time, are, at the Hydrographic Office, separated from the rest of the record, and entered in a book bearing the number of this square. For example, suppose a ship to be on her way from Liverpool to Cape Henry, a certain portion of her time will be passed in crossing from latitude 40° to latitude 35°, and from longitude 60° to longitude 65°. The square bounded by these latitudes and longitudes is square No. 782; therefore, in book No. 782 will be recorded all of the data taken from the time the vessel entered these limits till the time of her departing from them; at which time the succeeding data will be entered in the book of the succeeding square, and so forth.

By the arrangement of this data the Hydrographic Office comes in possession of observations extending over a number of days, months, or even years spent in this same square, although so remote from land as to preclude the idea of sending a vessel there to take continuous observations.

The periods of time that the various vessels have passed in each square are added together, and the mean of all observations is taken, and that is regarded as the state of the weather for that space of time at the center of this square. For each month the mean of all observations taken during months of that name represents the state of weather to be expected for that month in the future.

These observations consist in noting the temperature of the air and the water, the height of the barometer, the force and direction of the winds, the amount of time, and locality in which fog or rain is encountered, number and position of icebergs seen, etc., while the difference each day between the distance that the ship has traveled through the water and her absolute position, as determined by astronomical observations, shows the amount and direction of current that has been experienced from day to day.

The first chart having been made of any given section of the ocean, the work of the Hydrographic Office may be said to be only begun; constant care and vigilance must be exercised in securing and reporting changes and new dangers. Notice of these are received from all over the world and in all sorts of shapes. They include not only new discoveries made, new shoals formed, channels obstructed, and similar matters, but also changes made in positions of lights, buoys and other warnings, which are communicated promptly to each other by the hydrographic offices of the different civilized nations.

Among the early navigators it was a very common practice to place upon their charts warning marks which became denominated "Vigias," from the Spanish word, meaning "lookout."

A captain would see at some distance what appeared to be a shoal or breakers. It might be impracticable for him to make closer examination, yet he would report it as a *possible* danger.

This practice is kept up at the present day, but greater care is now taken to determine the absolute existence of the danger.

The Hydrographic Office issues a notice warning mariners of the *supposed* danger, and as soon as possible a vessel is sent to examine that locality.

Vigias are marked on the chart-plate thus, "* Vigia (?)." When it is found that they do not exist, a notice is issued to that effect, and the word and characters are removed from the chart-plate.

Should their existence be proved, the word "Vigia" and doubtful sign are removed from the chart-plate, and the rock or shoal is given a name.

Our naval vessels are constantly making surveys, which have expunged from the chart, or have verified, many of these supposed dangers.

There are over 8,000 light-houses in the world and hundreds of thousands of buoys. About 800, or one-tenth of all the light-houses, are on the coasts of the United States.

The use of a light-house is not always clearly understood by landsmen. It may be said to be simply an anchored star showing the mariner by *its* position what is *his* position; from his chart he ascertains where the light-house is placed, and shapes his course accordingly, and it is therefore of the greatest importance to him that he should have prompt and correct notice of any changes made in the position and character of lights.

IX.—BRANCH HYDROGRAPHIC OFFICES.

To facilitate the receipt and distribution of such information, it was deemed expedient in 1884 to establish branch hydrographic offices in the six largest seaboard cities—Boston, New York, Philadelphia, Baltimore, New Orleans and San Francisco; later, also, at Norfolk, Va., and Portland, Oregon.

All information that any of these branch offices can obtain is forwarded direct to Washington.

The offices are also depots where the latest information of any maritime nature whatsoever will be found.

For example, the change of character of a light, or the discovery of a shoal, on the French or Spanish coast, is reported by the Hydrographic Office of that nation to the Office at Washington. There the news is translated into English, published, and numbers of the notices issued to the several branch offices, from which, as centers, they are distributed along our entire coast.

A very important question to navigators is the determination of latitude and longitude. The latitude is easily ascertained, but the determination of longitude is a somewhat more intricate problem, and to this work the Hydrographic Office has given much attention. The general question of change of time with longitude is doubtless familiar to most intelligent people, and its discussion is hardly necessary here. At sea it is customary for navigators to change the time at noon, setting it back when going west and forward in going east, according as the longitude may have changed, the amount of change being determined by astronomical observation. The work of ascertaining these points has been very much simplified in later years by the increased excellence of the chronometer, and by the possibility of comparing the ship's chronometer with standards established on shore. These standards may be found at all the branch hydrographic offices in this country, and the use of the telegraph has enabled us to compare these standards at a number of different points, thus insuring their correctness.

In a word, these branch hydrographic offices are depots of marine information, where the captain of a vessel can find a full library of sailing directions and lists of all the charts published by the Government. Here he can obtain the latest information with regard to any port in the world, and can learn what charts or books may be necessary for him on the voyage he may be about to undertake.

The latest location of derelict vessels and floating icebergs are plotted upon the monthly pilot chart, on which also is recorded the limit at which ice may be expected in each month, and also the probable limits of foggy weather. This information is obtained from the reports received at the offices, and the probable limits of ice and

fog are recorded from experience. The limits in which the trade-winds are expected will also be found laid down on the chart. The experience referred to is the result of observations extending over many years, and each additional year adds to the accuracy with which probabilities may be laid down.

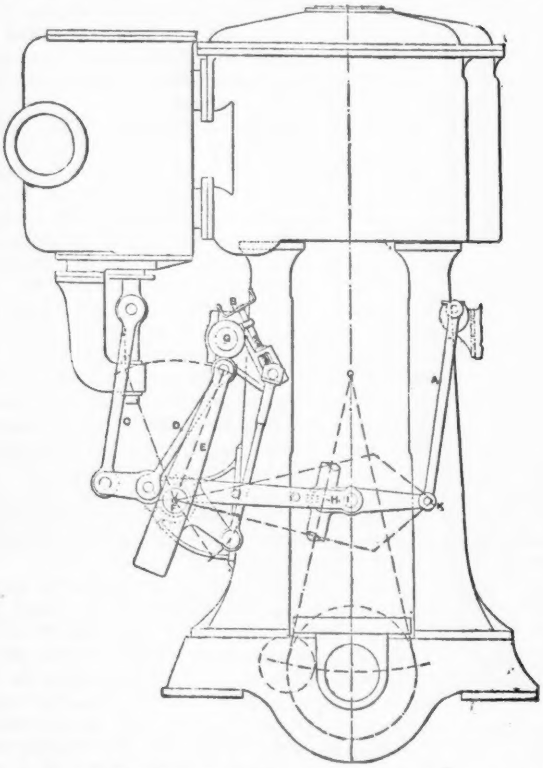
It may here be noted that the courses of some abandoned or derelict vessels have been plotted upon the charts from reports received, and some of these wandering wrecks have pursued erratic and remarkable paths. The schooner *Twenty-one Friends*, abandoned near Hatteras some six years ago, wandered about the North Atlantic for over two years, and was finally towed into a Spanish port on the Bay of Biscay.

In addition to furnishing information, the branch hydrographic offices also correct charts and adjust barometers, distribute lists of lights and beacons, and will obtain information which may be needed from the central Office at Washington.

As an instance of the amount of work one of these offices may be called upon to do, it may be stated that in the first four months of its establishment, the Norfolk office distributed 43 light-lists; 95 hurricane pamphlets; 2 reports on the use of oil to calm the waves; 70 day-marks; 576 pilot-charts; 832 supplements to pilot-charts; 1,864 notices to mariners; 14 coast survey notices; 11 monthly weather reviews and 9 cyclone charts. The Officer in charge reported 11 storms; 1 fog; 1 water spout; 26 wrecks; 10 buoys adrift and 8 light-ships adrift. He visited 132 different vessels; adjusted 3 barometers; corrected 120 charts and 3 day-marks, and gave information of different kinds to 3,834 persons.

A COMPOUND MARINE ENGINE.

THE accompanying illustrations, taken from *Industries*, show a very remarkable set of compound engines lately completed for the Italian armor-clad ship, *Ruggiero di Laura*, at the shops of Maudslay, Sons & Field, of London, England, from the designs of Mr. Charles Sell, the



head of the Engineering Department of that firm. The engines are of the three-cylinder compound type, having a high-pressure cylinder 61 in. in diameter and two low-pressure cylinders 80 in. in diameter each; the stroke of all being 39 in. As shown in the large engraving, the high-pressure cylinder is set in the middle, with a low-pressure cylinder on each side. The engines are upright and act directly upon the shaft, the cranks being set 120° apart. The framework is entirely of steel and is thoroughly braced together, so as to secure the greatest possible rigidity, combined with lightness, and in this way it has been found possible to obtain great power with a very moderate weight. With the exception of the cylinders, steel and gun-metal are the only materials entering into the construction of the engines.

The valve-gear of these engines is of the Joy pattern, fitted on the sling-link plan, in which the sliding block is replaced by an oscillating link. This type of gear is preferred for large engines in preference to the ordinary Joy gear, which is considered more suitable for small engines. An outline of the valve-gear is shown in the smaller cut, and its operation will be readily understood from this diagram. The sling-link *D* is suspended from a horseshoe lever *E*, which is supported in the fixed trunnion bearings *F*. The position of the horseshoe lever controls the cut-off and the direction of the motion, and this position is controlled by the main reversing lever *G*, a screw adjustment *B* being provided for the high-pressure cylinder, in order to give facilities for adjusting the proportion of cut-off in this and the two low-pressure cylinders. Motion is transmitted to the valve-lever *I* and the connecting-rod *C* by means of a connecting-lever *H K* suspended from the rod *A*. This arrangement of levers constitutes a kind of parallel motion and insures a correct cut-off both in forward and backward gear.

The contract for these engines provided that they should develop at least 10,000 H. P., but on the official trial trips, in the Gulf of Spezia, they attained a maximum of 12,000 indicated H. P., and the average for the whole trial was 11,400 indicated H. P. The engines thus showed a result of 14 per cent. in excess of the contract requirements.

OIL AS A METALLURGICAL FUEL.

(Paper read by E. C. Felton, before the American Institute of Mining Engineers.)

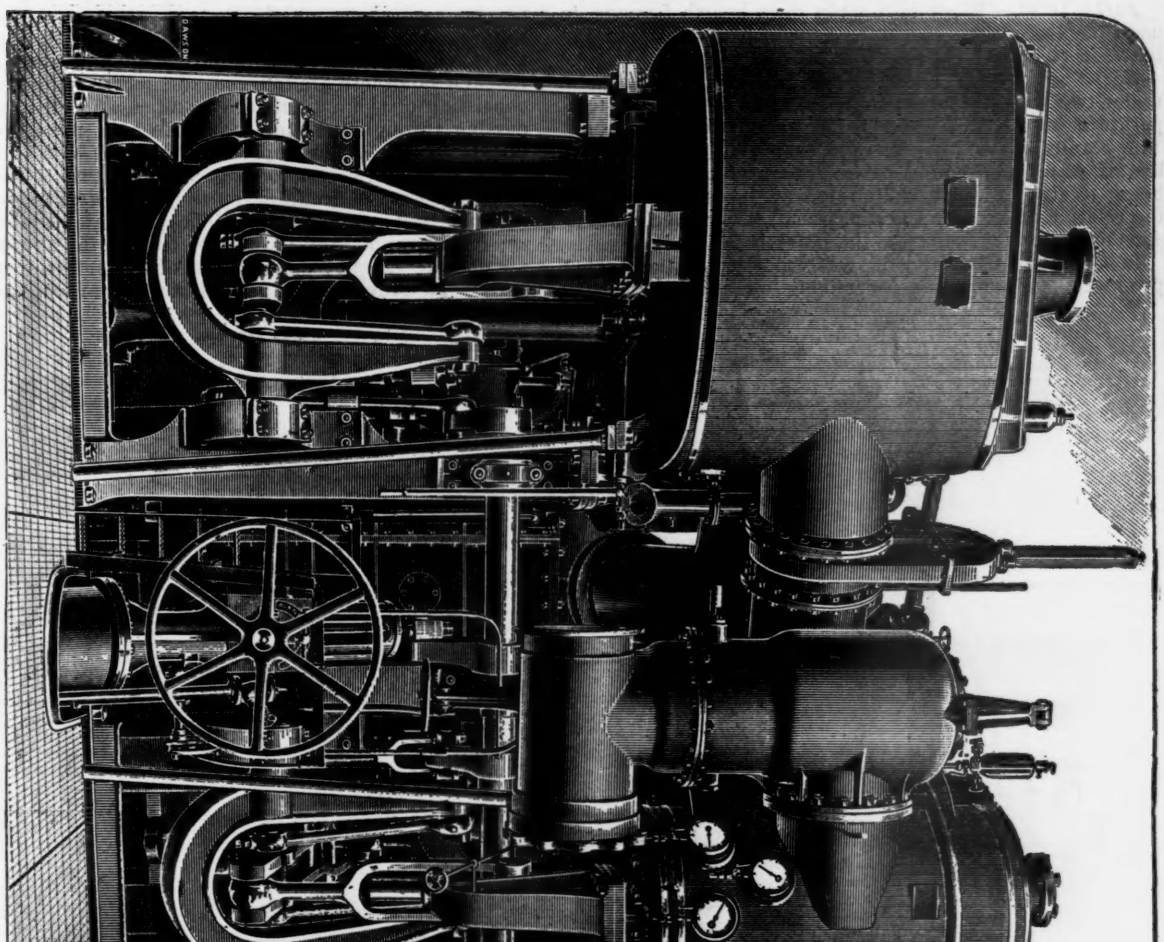
AT the Pennsylvania Steel Works, Steelton, Pa., a series of trials has been made with oil as fuel in steel-heating and open-hearth steel-furnaces with the following results:

First Trial.—Hot 14-in. ingots, six to a charge, were heated in two Siemens' heating furnaces in the blooming mill, the oil being put in first in March, 1888. The oil used had been partly refined, so that the paraffine and some of the naphtha were removed. During a run of six weeks the consumption of oil was about 6½ gallons per ton of blooms, including the oil required to keep the furnace hot over Sunday.

Second Trial.—The same partly refined oil was employed for melting in a 30-ton open-hearth furnace, the charge being cold scrap and pig, with ore. Although the gas was carried from the producer to the furnace, a distance of about 300 ft., the oil-consumption, as the average of a month's run, was 48 gallons per ton of ingots, including the oil required to keep the furnace hot over Sunday.

Third Trial.—Oil was introduced on June 11, 1888, to heat six Siemens' heating-furnaces in the blooming mill, and has since then been constantly used. For a period of six months, including the fuel-consumption on Sundays, and including the heating of some cold ingots, the consumption of Lima oil was 6 gallons per ton of blooms. The quantity of oil required naturally varies with the product of the mill. Under the most favorable circumstances—charging hot ingots and with all the stock supplied which the furnaces can handle—4½ to 5 gallons of oil are required per ton of blooms. Cold ingots must remain in the furnace for about three hours.

Fourth Trial.—Lima oil was used for heating a 30 ton open-hearth furnace, the producer being located near it. As the average of a six weeks' run, 54 gallons of oil were required per ton of ingots, including the fuel consumption over Sundays and for starting the furnace. The record of the first week was 46.7 gallons of Lima oil per ton of in-



COMPOUND ENGINES OF ITALIAN CRUISER "RUGGIERO DI LAURA."

gots. It was found that the loss is somewhat greater than with coal-gas, and that some trouble was experienced from the fact that fine particles of oxidized iron clogged the checkers.

Fifth Trial.—Work in a 5-ton open-hearth furnace, in use since December, developed a fuel consumption ranging between 50 and 55 gallons of oil per ton of ingots.

Sixth Trial.—Oil was applied to the raising of steam under two 100 H.-P. return-flue tubular boilers, the temperature of the feed-water being about 160° Fahrenheit. The results showed an average evaporation of about 12 lbs. of water per pound of oil, the best 12 hours' work being 16 lbs. of water evaporated per pound of oil. At the relative prices of oil and pea-coal, the former is not as economical under boilers as the latter.

In all of the trials the oil was vaporized in the Archer producer, an apparatus for mixing oil and superheated steam, and heating the mixture to a high temperature. From 0.5 to 0 75 lb. of pea-coal is used, per gallon of oil, in the producer itself.

A BRIDGE OF OLD RAILS.

(A. T. Lahiri in the *Indian Engineer.*)

OLD railroad iron has hitherto been utilized only in the construction of culverts and bridges of a very limited span. A new departure has lately taken place in the use of the material, for, on June 22, a bridge of 236 ft. clear waterway, wholly composed of rails, was opened for traffic in the Rangpur District.

A description of this work may be interesting to your readers ; for it appears to combine cheapness and strength. The height is 25 ft. above the bed-level, and 9 ft. above the highest flood-level of the River Ghagat which it spans. The piers, eight in number, are of two rows of rail piles placed 5 ft. apart ; each row, consisting of three single piles 4 ft. apart, is strongly scarfed with steel fish-plates and scarfing plates 3 in. × 5 in. × ⅞ in. The piles are driven to a depth of 14 to 15 ft. by 2 ft. diameter cast-iron screws. In driving, a hard layer of earth 2 to 3 ft. deep was met with at a depth of 4 ft., and below this there is ordinary sand of the Terai down to a depth of 45 ft., in which the piles are imbedded. They are braced strongly on all sides, both diagonally and horizontally, with old rails, thus forming a strong pier 8 ft. × 5 ft., and are topped with a bracket piece of channel iron fixed by strong bolts, on which rest rail waling pieces.

The superstructure is very simple ; it consists of six rail corbels 2 ft. apart each, carrying a rail girder, over which roadway planking of 6 in. × 3 in. teak scantlings are laid and held down at two sides by clip bolts passing through two teak wheel-guards of 4 in. × 4 in. section. The hand railings consist of T-iron uprights 5 ft. and 3 ft. 6 in. high, alternately, fixed by bolts to side girders and wheel-guards. At each side there are four parallel pieces : the lower two consisting of 1¼ in. diameter gas-tubes, and the upper two, passing through the high standards only, are of ordinary telegraph wire. The superstructure is braced to its supports by ⅞ in. × ⅞ in. strong stirrup pieces. The abutments consist of puddled earth sloped two to one, well rammed and neatly turfed. The piles at the abutments are underground, and the two piers next the abutments of a moderate height : both consist of a single row of three piles. To prevent oscillation from lateral wind and current-pressure, the high piers have been strutted on the upstream side by rails running from the top of each row of the pier-piles to fender posts, driven for the purpose 16 ft. from the bridge. These will act both in tension and compression. The iron-work has been fixed throughout with strong bolts, as riveting in this backward district would have been costly and unsatisfactory. The approaches to the bridge are 20 ft. wide, and have been constructed with a gradient of 1 in 100, which will not tax the tractive power of bullocks too heavily. The bridge is constructed with a headway of 9 ft. clear above the highest known flood, identical with that allowed on the railway line a few miles up-stream. The bridge consists of four spans of 17 ft. 6 in., and seven of 18 ft., while the piers provide for eight clear spans of 5 ft. each, so that the total opening is 236 ft. Its clear width is 10 ft., sufficient for a single cart to pass. A bridge calculated for a double line of carts would have been too costly for the limited funds at the disposal of the District Board, under the auspices of which it has been constructed.

This useful work occupied only 15 weeks in completion, including the high approach roads, and this in spite of some delay in procuring materials and tools from Calcutta. At the beginning of March last earth-work at the approaches was taken in hand. On March 16 the staging was taken in hand and the first pile was hoisted March 28. Up to April 15 the work progressed but slowly, and for three days was at a standstill, owing to the delay in getting materials and the greater difficulty in procuring skilled labor. However, by dint of constant exertions, the pile driving was resumed on April 15 and finished on May 10. The work of fitting and fixing the superstructure occupied from May 10 to June 15. There was no lack of unskilled

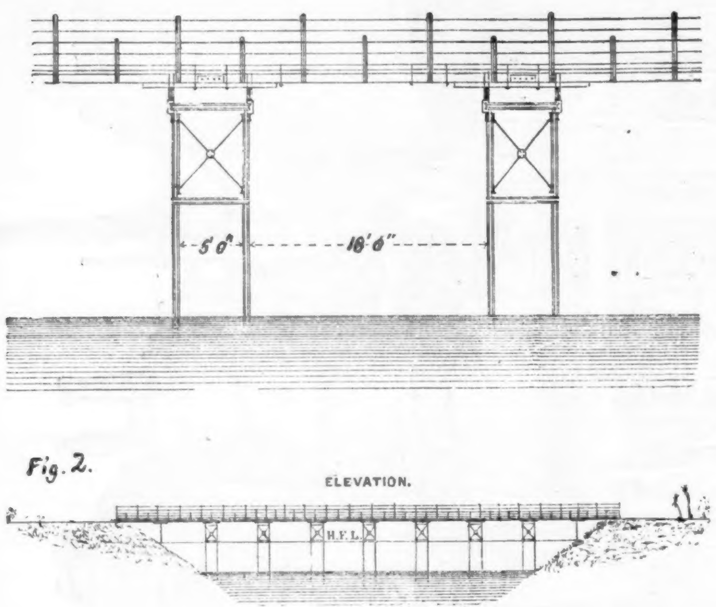


Fig. 2.

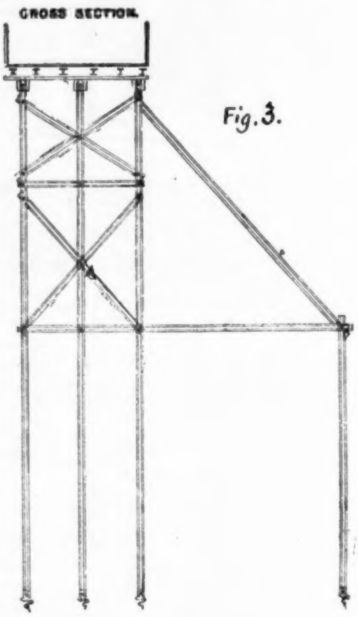


Fig. 3.

A BRIDGE OF OLD RAILS.

laborers, who were supplied by Rup Lal Mistry, a railroad contractor, whose resources are very large; but smiths and carpenters were imported from Rajshahye and Naddya, as none were locally available.

The actual cost is as yet uncertain, but there is no reason to doubt its exceeding the estimate of $6,250, including a new diversion road and high approaches. It does not exceed $26.50 per running foot, including cost of approaches, and, all things considered, must be considered extremely moderate.

THE DEVELOPMENT OF THE MODERN HIGH-POWER RIFLED CANNON.

By Lieutenant Joseph M. Califf, Third U. S. Artillery.

(*Continued from page* 403.)

II.—PROJECTILES.

Up to the time of the advent of the armor-plate, projectiles of all kinds—solid and hollow—were made of cast-iron. Against a target of this kind common cast-iron lacks tenacity, and a projectile of this metal will fly to pieces like glass. Wrought-iron, on the other hand, while possessing great tenacity, is wanting in hardness, and flattens out like lead upon impact with the hard face of an armor-plate.

The first advance in the direction of securing greater penetrating power for projectiles was in the manufacture of what were known as chill-shot. The metal, of carefully selected qualities of iron, was cast in metallic molds, and, of course, rapidly cooled. The product possessed great hardness and considerable tenacity. In Germany it was known as Grüson cast-iron. In England projectiles of this kind were known as Palliser shot and shell. They differed from both the Grüson and the French chilled projectiles in that only the head was cast in chill, the body having the ordinary sand mold.

When in the development of the armor-plate wrought-iron gave place to steel, and at the same time the powder-makers and the gun-makers in conjunction gave us well-nigh double the old velocities, it was found that even the best chilled cast-iron projectiles failed to do the work required of them, resort was had to steel.

All armor-piercing projectiles are now made of steel, and almost without exception are hollow. Battering shell and cored shot are almost identical in shape. Their general form is shown in figs. 12, 13, and 14. The advantage of a hollow over a solid projectile lies in the fact that in it the center of gravity is thrown well toward the point and greater steadiness of flight and less inclination to glance off should the plate be struck at an angle. If a bursting charge be used, we have the additional effect of the explosion to be added to the energy of impact.

The fabrication of these projectiles requires great care and skill. In France, where their manufacture began, they have reached a high degree of excellence. Other European powers have followed suit upon different lines, but all employing steel of the finest quality, cast or forged, and tempered with as much care as one would give to a fine piece of cutlery. In the United States little progress has as yet been made in procuring armor-piercing projectiles. The Secretary of the Navy, in his last report, laments that during the previous year but *one* serviceable shell had been furnished. In England, for some time, Armstrong's was the only firm which would undertake to furnish forged and tempered steel shell, but of late a number of Birmingham and Sheffield firms are engaged upon this kind of work.

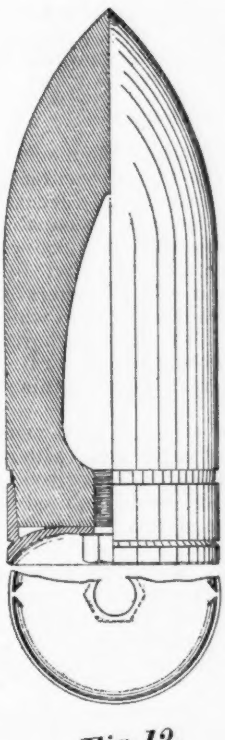


Fig. 12.

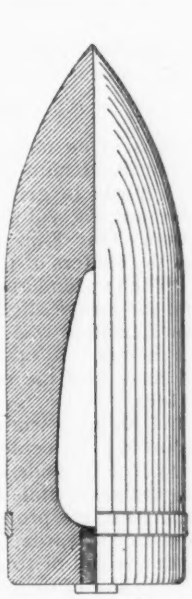
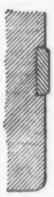


Fig. 13.



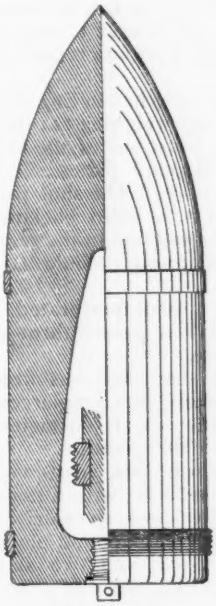


Fig. 14.

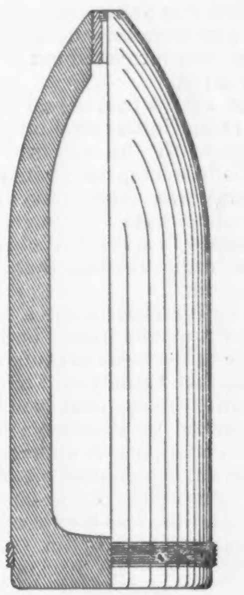


Fig. 15.

The first cast-steel armor-piercing shell were cast solid, point down, with a sinking head. The mold for the point and body was metallic, while that of the sinking head was of sand. When cool the sinking head was cut off and the chamber bored out in a lathe. To temper, the projectile was heated in a reverberatory furnace to a cherry-red, the point receiving a higher temperature than the base, and then plunged into cold water and immediately afterward immersed in oil. Later fabrications are cast hollow.

Forged steel armor-piercing shell are cut from steel bars of proper size. They are hammered to the general form of the shell, and afterward turned and tempered. The details of the manner of tempering followed at the French works at St. Chamond are interesting. The shell are first brought to a cherry-red throughout, plunged in oil and kept immersed until cold; they are then again brought to a cherry red, hung with the head, as far as the front band, in cold water for ten minutes, and afterward immersed in oil until cold. After this treatment they cannot be touched with a file, and possess a tenacity that will take them through a steel target equal to their own diameter, or greater, and often without a scratch.

In the Low (English) projectile, the metal is forged and turned as indicated above, and after being brought to a red heat is placed-point down in a metal mold and sub-

jected to a gradually increasing hydraulic pressure. Great hardness of point and tenacity are obtained.

The manufacture of these armor-piercing steel projectiles is hardly beyond the experimental stage, and yet to understand the wonderful results attained it is necessary to read of some of the competitive trials that have taken place since 1885.

In some trials had in Italy three years ago, to test the relative merits of Holtzer chrome steel and Krupp steel shell, three empty shell weighing about 80 lbs. each were fired at short range from a 5.9-in. Armstrong gun, with a 40-pound charge against an 18.9-in. solid steel Creusot plate, with a velocity of a trifle less than 1,900 feet-seconds. The report goes on to say that with the Holtzer chrome projectiles each of the three penetrated the plate a depth of but little less than 10 in., and the "shell *rebounded in each case entire, without any appreciable deformation.*" With the Krupp projectiles the penetration was nearly 9 in. for each, which "rebounded entire; slight setting up of body, but more marked than in the Holtzer shell."

We also read of an experiment made about the same time (1886) in Russia, to test the merits of Krupp and St. Chamond (French) steel projectiles, in which an 11-in. 554 lbs. St. Chamond, with an initial velocity of nearly 1,500 feet-seconds, penetrated 15½ in. into a Cammell compound plate, rebounded 30 ft. and was found to be intact.

In December of the same year a St. Chamond 42-cm. steel battering shell was driven *through* a 19.7-in. Creusot steel plate, with a striking velocity of but a little over 1,400 feet-seconds, and was recovered entire and without cracks and but slightly set up.

In October, 1887, a trial of projectiles was had in England, in which a 12-in. Holtzer steel projectile, weighing 714 lbs., with a charge of 295 lbs. was fired against one of the best Brown & Co.'s steel-faced 16-in. compound plates. The striking energy was about 1,700 foot-tons. The shot perforated the plate, passed through 10 ft. of solid backing, and was stopped by a piece of old armor-plate in the rear, "and was so little deformed that apparently it could have been fired again."

In the English experiment a 6-in. shell perforated a 9-in. Brown compound plate; one of 8 in. passed through a 12-in. plate of the same manufacture.

At Gâvres, last autumn, a French steel shell was fired against a 15¾-in. Creusot plate (solid steel), which it pierced, and when picked up afterward in the sea, 1,500 meters beyond, had undergone no appreciable deformation.

During some experiments at Meppen, last year, with Krupp steel projectiles, two 21-cm. steel shot, with a striking energy of a little less than 8,000 foot-tons, were driven in succession through a 15¾-in. Cammell compound plate, supported by substantial backing of oak and two skin plates, and when recovered were slightly upset, but otherwise were uninjured.

In connection with these reports it must not be forgotten that in these trials the conditions were always favorable for the gun, the ranges were very short, and, in the instances cited, the impact was normal to the surface of the plate—two conditions not likely to occur in an actual engagement. It must also be borne in mind that in these tests the projectile was not always successful. There were many times where the shot only half did its work. They are given to show what the high-power gun, provided with projectiles worthy of it, *can* do, when pitted against its old enemy, the armor-plate. That the gun, at the date of present writing, has the advantage, can hardly be questioned; that it will maintain the lead is by no means certain, though, it seems to us, extremely probable. It might be added that at various times during these trials chilled cast-iron projectiles, of the Palliser and other types were tried, and without exception broke up without inflicting any appreciable injury to the plate.

The first projectiles for rifled guns were about 1½ calibers in length. To-day 3½ calibers is the usual length. For armor-piercing various forms of head have been experimented with. Projectiles with flat heads and with concave heads, to insure their taking hold when striking at an angle, have been tried, but at present nearly all projectiles have the ogival head, struck with a radius equal to about 1½ diameters.

III.—ENDURANCE.

Every piece of ordnance has a certain length of life, varying with the different conditions of metal, method of construction, charge, projectile, and system of rifling, if rifled. This life is measured by the number of rounds it may be fired without danger of rupture. In the days of smooth-bore guns about 1,000 rounds was considered as the measure of their life. With the Parrott cast-iron, reinforced rifles used during the Rebellion, about 250 rounds was considered the limit of their safety. When fired beyond this number precautions were taken to assure the safety of the cannoneers in case of bursting. Some burst before this number had been fired, others exceeded it, and one is said to have reached its two-thousandth round before rupture. It was never possible to predict when these guns would succumb. In the experiments with converted guns a number of them were fired from 500 to 800 rounds and still remained serviceable. Of two 8-in. cast-iron rifles cast in 1865 one burst at the eightieth round, while its companion piece was fired more than 800 rounds without bursting. Cast-iron in this case, as in that of the Parrott rifles, was found to be unreliable.

The life of the built-up, high-power steel gun has not as yet been fixed. Our 8-in. Army rifle has been fired over 200 rounds without appreciable deterioration. Some of the Navy guns have considerably exceeded this number. One of the 119-ton Krupp guns has been fired 200 rounds and is still in good condition. It is, perhaps, safe to say that the limit of safety will fall somewhere between 300 and 500 rounds.

IV.—ACCURACY.

Perhaps in no one quality does the modern gun excite our admiration more than in that of accuracy. Many instances might be given of wonderfully accurate practice. A few examples will show, however, its capabilities in this direction. Our 8-in. Army rifle at 3,000 yards range, placed the centers of 10 shots within a circle 6½ ft. in diameter. The 119-ton Krupp gun at 2,500 meters (2,734 yards), in nine successive shots, made a target in which the mean vertical deviation was but 1.1 meters, the horizontal deviation, 2 meters. In other words, a circle 12 ft. in diameter would have held the centers of all these nine ton-weight projectiles.

In the Meppen trials of 1879 a Krupp 71-ton gun put consecutively the centers of eight shots within a parallelogram 5 ft. 8 in. wide by 19 in. high, at 2,700 yards range. During the same trials a 4½-in. field gun, fired under a high angle and using a projectile of less than 30 lbs. weight, at a target 10,300 yards distant (about six miles), put 50 per cent., or five out of 10 shots, within a parallelogram 20 by 80 ft.—the size of the deck of a small steamer.

In April of the present year, at Shoeburyness, in England, the 4.72-in. Armstrong rapid-fire gun, at 1,300 yards, made five hits out of five shots on a six-foot square target, in 31 seconds.

What is expected, as regards accuracy, of guns in the future, is well shown in the stipulations of our Army Fortification Board previously referred to. At 1,500 yards both the 10-in and 12-in. guns are to put 25 per cent. of their shot in a rectangle 1 by 1.4 ft., and at 10,000 yards into a rectangle 9.2 by 48.5 ft.

V.—RANGE.

The extreme range of very few high-power guns has been determined by actual firing. The difficulty of getting a carriage that will withstand the enormous strain brought upon it by high-angle fire, limits the *practicable* to but little more than one half the *possible* range of most of these guns. The maximum possible range of the best of them is about 12 miles. On shipboard about seven miles may be considered the maximum practicable range. During the English Jubilee last year a round for range was fired at the Shoeburyness practice-ground from the 9.2-in. wire-wound gun. The measured range was 21,000 yards, a trifle less than 12 statute miles. Our 8-in. B. L. Army rifle, with a charge of less than 100 lbs. has given a range of over six miles.

The value of a piece of ordnance is determined by the amount of work it can accomplish, and is measured by the number of foot-tons of energy it is capable of imparting to its projectile. This energy may be expended either in overcoming atmospheric resistance—that is, in range, or, as in heavy guns, in beating down walls or penetrating armor plates. It will vary directly as MV^2. In comparing the capabilities of guns of different calibers this energy is usually expressed in terms of foot tons per inch of circumference of projectile. If a racking or smashing effect were desired then the totals would determine the best gun. If, however, range or penetration were to be the test, the energy per unit of surface would properly be the standard of comparison.

With high-power guns the measure of efficiency is usually stated in terms of the number of inches of wrought-iron plate its projectiles will perforate. In a rough way it may be stated that a pointed projectile will penetrate about its diameter in wrought-iron for every 1,000 ft. of velocity at moment of impact. For penetration in steel an allowance of from 25 to 30 per cent. must be made.

In the fabrication of heavy guns, both as regards ballistic qualities and actual size, Krupp leads in the race. His largest gun, which is the largest ever yet constructed, is a 119-ton piece, with a caliber of 15.75 in. and capable of throwing a 2,300 lb. projectile. Four of these guns were finished three years ago for the Italian Government ; three have been delivered and one is still retained for experimental purposes.

HEAVY ORDNANCE OF DIFFERENT NATIONS.

Country.	Character of Gun.	Weight, tons.	Caliber, inches.	Powder, pounds.	Shot, pounds.	Muzzle velocity, feet-seconds.	Muzzle energy, foot-pounds.	Length of bore, caliber.	Penetration in wt.-iron at 1,000 yards
Engla'd	Steel B. L. (wire)..	22	9.2	270	380	2520	18,728	..	23.2
"	Wt.-Iron & Steel—M. L...	100	17.75	575	2000	1735	46,300	20	28.5
"	Steel B. L.........	105	17	772	2000	1814	45,675	27	29.7*
"	" "	111	16.25	1000	1800	2128	57,680	30	33
France	" " (34 cm.)	52	13 4	337	926	1968	24,870	28.5	24.8*
"	" " (42 ").	75	16.5	295	1720	1739	36,000	22	26*
G'many	Krupp Steel (B. L.)	71	15.75	485	1715	1700	34,500	20	23.8
"	" " "	119	15.75	846	2314	1899.5	58,122	31.8	35
Russia.	Steel, B. L..	80	16	....	....	...	....	..	..
U. S...	Cast-iron, B. L....	55	12	250	800	1700	16,187	28	19.5
" ..	" and Steel-converted	7.5	8	35	180	1385	2,480	14.7	7.42
" ..	Steel, B. L., Army	13⅜	8	113	300	1875	7,200	30	..
" †..	" " "	27	10	....	....	....	. ..	..	..
" ..	" " Navy	12	8	112	250	2008	7,285	30	18.2*
" ..	" " "	25	10	250	500	2002	13,870	31	21.5*
	PROPOSED GUNS.								
Engla'd	Steel, B. L. (Woolwich)...........	156	19	....	...	....	...	..	..
G'many	Steel, B.L.(Krupp)	139	15.75	....	2300	....	...	..	..
"	" " "	150	17.5	....	3300	....	. ..	..	..
U. S...	" " (Army)	30	10	.. .	575	....	15,000	34	..
" ..	" " "	52	12	...	1000	...	26,000	34	..
" ..	" " (Navy)	44	12	425	850	2100	25,985	35	27.6*
" ..	" " "	75	14	675	1350	2100	41,270	..	32.2*
" ..	" " "	110	16	1000	2000	2100	61,114	32	36.8*
	RAPID-FIRE GUNS.								
Engla'd	Armstrong........	4200	4 72	12	45	2073	...	33	10*
"	"	..	6	42	110	...	. ..	..	15*
G'many	Krupp............	2645	4.13	8.6	40	1729	....	35	..
"	"	5510	5.12	17.6	66	1640	...	35	..
France &U.S	Hotchkiss..... ...	3637	4	12.5	33	2034	....	42	10*
U. S...	Driggs-Schroeder..	..	4	....	....	.. .	....	..	..

* At muzzle. † Under construction.

England follows closely with her 111-ton Woolwich gun, which, though of considerably less weight than its German rival, uses a larger powder charge and very closely approaches it in the total energy stored up in its projectile. France has finished a number of 42-centimeter guns of 75 tons weight ; they have, however, not yet been sufficiently tested to enable one to judge of their relative merits. In the United States a 10-in. 25-ton steel gun is the best we can show, and with the best of luck in our gun-making the last decade of the century will be well toward its close before we can hope to reach the present state of efficiency now attained in European ordnance.

In the table given herewith I have endeavored to show the present state of heavy ordnance possessed by the leading military powers of the world, and the best recorded performances of the guns described. Of modern high-power rifles England, France, Germany, and Russia may be said to be the only European nations having distinctive systems ; to this list we may now add the United States. Italy, while ambitious to develop a system of ordnance of her own, is as yet dependent upon England and Germany. Spain, too, is said to be about to attempt heavy gun construction on her own account. The lesser powers of Europe, the South American Republics, Egypt, China, and Japan look to European gun-makers for their supply of heavy guns.

In the development of heavy ordnance it is to be observed that, while during the past 10 years guns have greatly increased in both weight and length of bore, the caliber has remained stationary or has somewhat decreased. The 71-ton Krupp had a 15.75-in. bore ; the 119-ton gun is the same. The caliber of the original 100-ton English gun was 17.75 in., that of the 111-ton gun is 16.75 in. While Krupp is now building a 140-ton gun of some 40 calibers in length, the diameter of the bore is to remain the same as in the other guns in his system—40 centimeters. The English, however, in their proposed 156-ton gun seem to have fixed upon a 19-in. bore. There are not wanting military authorities to predict that the gun of the future will be, relatively speaking, of smaller caliber than those that are being turned out to-day. If we can increase the length of projectiles to 4½ or 5 calibers, and at the same time secure increased initial velocity, we can well afford to reduce somewhat the caliber of our guns, and still be able to penetrate any practicable thickness of armor that a ship can carry, while the gain in the matter of ease of manipulation and rapidity of fire will be a decided one.

THE GIRARD HYDRAULIC RAILROAD.

(From *Industries*.)

WE give herewith some illustrations of this railroad, which has recently excited so much technical interest in Europe and America, and which threatens to revolutionize both the method and velocity of traveling, if only the initial expense of laying the line can be brought within moderate limits. A short line has been laid in Paris, and we have there examined it, and traveled over the line more than once ; so that we can testify to the smoothness and ease of the motion. Sir Edward Watkin examined the railroad 10 days ago, and we understand that a line two miles long is to be laid in London, under his auspices. He seems to think it might be used for the Channel Tunnel, being both smokeless and noiseless. It might also, if it could be laid at a sufficiently low price, be useful for the underground railroads in London. We are favorably impressed by the experiments we have witnessed ; our misgivings are as to the cost.

The railroad is the invention of the well-known hydraulic engineer, M. Girard, who, as early as 1852, endeavored to replace the ordinary steam traction on railroads by hydraulic propulsion, and in 1854 sought to diminish the resistance to the movement of the wagons by removing the wheels, and causing them to slide on broad rails. In order to test the invention, M. Girard demanded, and at the end of 1869 obtained, a concession for a short line from Paris to Argenteuil, starting in front of the Palais de l'Industrie, passing by Le Champ de Courses de Longchamps, and crossing the Seine at Suresnes. Unfortunately, the war of 1870–71 intervened, during which the works were destroyed, and M. Girard was killed. After

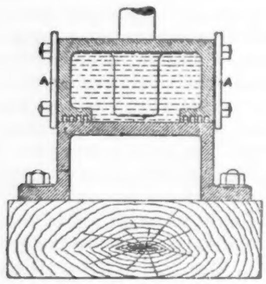


FIG 1.

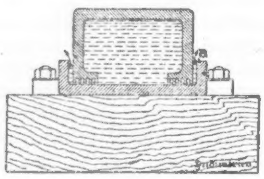


FIG 2.

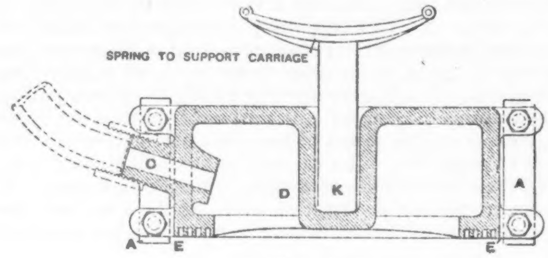


FIG. 3.

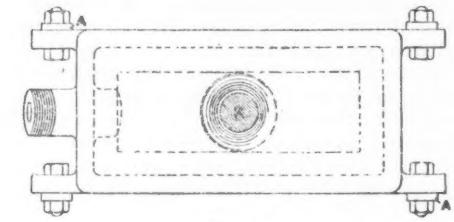


FIG. 4.

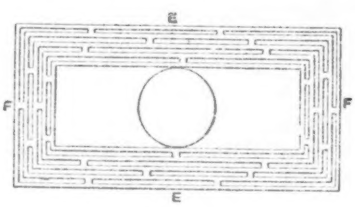


FIG. 5.

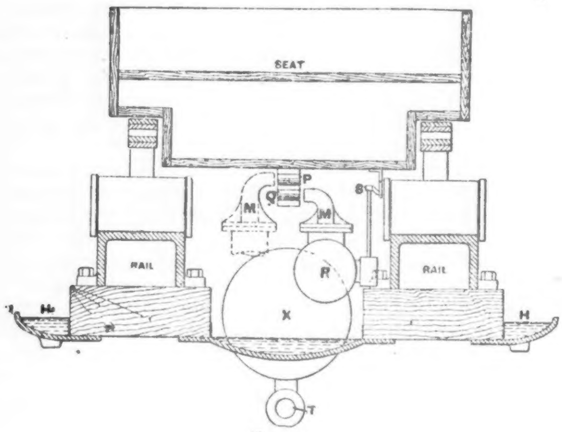


FIG. 6.

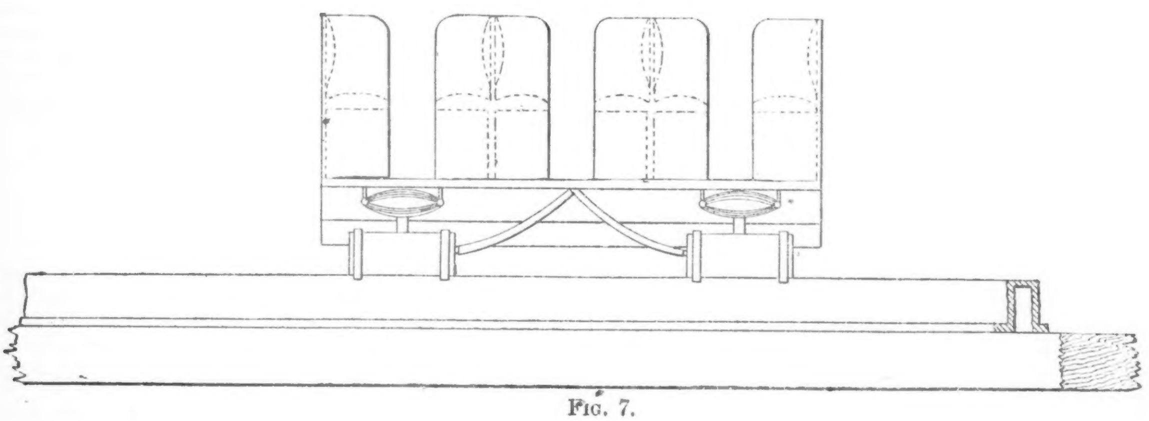


FIG. 7.

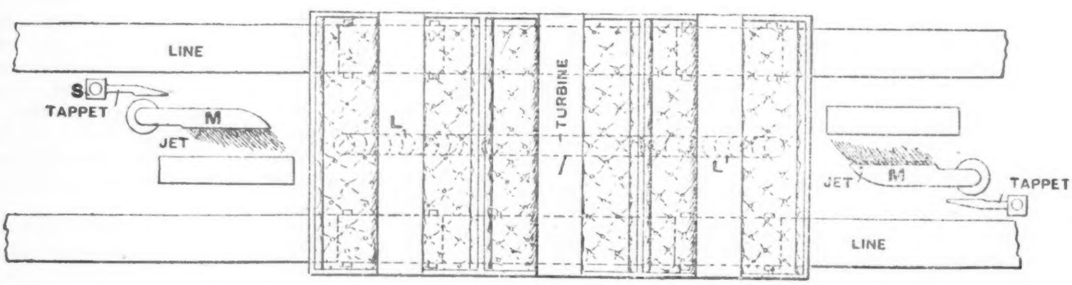


FIG. 8.

THE GIRARD HYDRAULIC RAILROAD AT THE PARIS EXPOSITION.

DETAILS OF CONSTRUCTION.

his death the invention was neglected for some years. A short time ago, however, one of his former colleagues, M. Barre, purchased the plans and drawings of M. Girard from his family, and having developed the invention, and taken out new patents, he formed a company to work them. The invention may be divided into two parts, which are distinct, the first relating to the mode of supporting the carriages, and the second to their propulsion. Each carriage is carried by four or six shoes, shown in figs. 3, 4, and 5; and these shoes slide on a broad, flat rail, 8 in. or 10 in. wide. The rail and shoe are shown in section in fig. 1. The rail is bolted to longitudinal wooden sleepers, and the shoe is held on the rail by four pieces of metal *A*, two on each side, which project slightly below the top of the rail. The bottom of the shoe which is in contact with the rail is grooved or channeled, so as to hold the water and keep a film between each shoe and the rail. The carriage is supported by vertical rods, which fit one into each shoe, a hole being formed for that purpose; and the point of support being very low, and quite close to the rail, great stability is insured. It is proposed to make the rail of the form shown in fig. 2 in future, as this will avoid the plates *A*, and the flanges *B* will help to keep the water on the rail. Figs. 3, 4, and 5 show the shoe in detail. Fig. 3 gives a longitudinal section, fig. 4 is a plan, and fig. 5 is a plan of the shoe inverted, showing the grooves in its face. Fig. 3 shows the hollow shoe, into which water at a pressure of 10 atmospheres is forced by a pipe from a tank on the tender. The water enters by the pipe *C*, and fills the whole of the chamber *D*. The water attempts to escape, and in doing so lifts the shoe slightly, thus filling the first groove of the chamber. The pressure again lifts the shoe, and the second chamber is filled; and so on, until ultimately the water escapes at the ends *E* and sides *F*. Thus a film of water is kept between the shoe and the rail, and on this film the carriage is said to float. The water runs away into the channels *H H* (fig. 6), and is collected to be used over again. Fig. 3 also shows the means of supporting the carriage on the shoe by means of *K*, the point of support being very low. The system of grooves on the lower face of the shoe is shown in fig. 5. So much for the means by which wheels are dispensed with, and the carriage enabled to slide along the line. The next point is the method of propulsion. Figs. 7 and 8 give an elevation and plan of one of the experimental carriages. Along the under side of each of the carriages a straight turbine, *L L*, extends the whole length, and water at high pressure impinges on the blades of this turbine from a jet, *M*, and by this means the carriage is moved along. A parabolic guide, which can be moved in and out of gear by a lever, is placed under the tender, and this on passing strikes the tappet *S* and opens the valve which discharges the water from the jet *M*, and this process is repeated every few yards along the whole line. The jets *M* must be placed at such a distance apart that at least one will be able to operate on the shortest train that can be used. In this turbine there are two sets of blades, one above the other, placed with their concave sides in opposite directions, so that one set is used for propelling in one direction and the other in the opposite direction. In fig. 6 it is seen that the jet *M* for one direction is just high enough to act against the blades *Q*, while the other jet is higher, and acts on the blades *P* for propulsion in the opposite direction. The valves *R*, which are opened by the tappet *S*, are of peculiar construction, and we hope soon to be able to give details of them. Reservoirs (fig. 6) holding water at high pressure must be placed at intervals, and the pipe *T* carrying high pressure water must run the whole length of the line. Fig. 6 shows a cross-section of the rail and carriage, and gives a good idea of the general arrangements. The absence of wheels and of greasing and lubricating arrangements will alone effect a very great saving. M. Barre thinks that a speed of 200 kilometers (or 124 miles) per hour may be easily and safely attained. Of course, as there is no heavy locomotive, and as the traction does not depend upon pressure on the rail, the road may be made comparatively light. The force required to move a wagon along the road is very small, M. Barre stating, as the result of his experiments, that an effort amounting to less than half a kilogramme (about 1 lb.) is sufficient to move one ton when suspended on a film of water with his improved shoes. It is recommended that the stations be placed at the summit of a double incline, so that on going up one side of the incline the motion of the train may be arrested, and on starting it may be assisted. No brakes are required, as the friction of the shoe against the rail, when the water under pressure is not being forced through, is found to be quite sufficient to bring the train to a standstill in a very sort distance. The same water is run into troughs by the side of the line, and can be used over and over again indefinitely; and in the case of long journeys, the water required for the tender could be taken up while the train is running. The principal advantages claimed for the railroad are: the absence of vibration and of side-rolling motion; the pleasure of traveling is comparable to that of sleighing over a surface of ice; there is no noise, and what is important in towns, there is no smoke and no dust is caused by the motion of the train during the journey; it is not easy for the carriages to be thrown from the rails, since any body getting on the rail is easily thrown off by the shoe, and will not be liable to get underneath, as is the case with wheels; the train can be stopped almost instantly, very smoothly and without shock; very high speeds can be attained; with water at a pressure of 220 lbs. a speed of 85 miles per hour can be attained; great facility in climbing up inclines and turning round the curves; as fixed engines are employed to obtain the pressure, there is great economy in the use of coal and construction of boilers, and there is a total absence of the expense of lubrication. It is, however, difficult to see how the railroad is to work during a long and severe frost.

THE MOUNT PILATUS RAILROAD.

As a supplement to the description of this remarkable railroad, given in the JOURNAL for September, we give the following details of construction:

The line is single-track, with the exception of a short piece at Aemsigen-Alp, where there is a second line of rails for the passage of the up and down trains. About one-half of the total length of line is straight, the other half being composed of curves, all of 80 meters (262.4 ft.) radius. There is one viaduct of 25 meters (82 ft.) span, and seven tunnels had to be made, varying in length from 9 meters (29.5 ft.) to 97 meters (318 ft.). The gauge is 0.8 meter (31½ in.), and the foundation for the rails and the central rack rail is formed of masonry, with coping of heavy granite slabs.

The locomotive, which had to be specially designed for this line, has its boiler placed at right angles to the line of rails in order to minimize the disturbance of water-level due to variations in the gradients. The pinions are driven by bevel gear from the main axles, and the cylinders are placed outside, with valve-chests inclined and below. The following are the principal data of these engines, which were built by the Swiss Locomotive and Machine Company at Winterthur, Switzerland: Diameter of cylinders, 0.220 meter (8.66 in.); stroke, 0.300 meter (11.81 in.); revolutions per minute for a speed of 1 meter per second, 180; heating surface of boiler 20 square meters (215.28 square ft.); working pressure, 180 lbs.; weight of locomotive and car empty, 5.7 tons; in service, 10.5 tons; pressure on rack on the 48° grade, 4.6 tons. The pinion-wheel which engages in the rack is 0.411 meter (16.2 in.) diameter, and has 15 teeth, the pitch being 0.0857 meter (3.374 in.). The car is 10.4 meters (34.11 ft.) long over all, and 2.2 meters (7.22 ft.) wide.

Three distinct brakes are provided: (1) an air-brake acting upon all the running wheels of the locomotive and car; (2) a hand-brake acting upon the axles of the locomotive; (3) a hand and automatic brake acting upon the two upper pinions through the intervention of clutches, worm, and worm-wheels. On the up journey the clutches are out of gear and the worms are at rest; but on the down journey the clutches are in gear and the worms are running at about 300 revolutions. The brake acts upon the worm spindle and can be tightened by hand. A centrifugal apparatus is, however, added, which puts this

brake on when the speed of the worm spindle exceeds 300 revolutions per minute.

The line has now been in regular work since the beginning of June last, and as regards safety and regularity of the service leaves nothing to be desired.

A FRENCH PASSENGER BOAT.

THE accompanying illustrations, from *Le Genie Civil*, show a small passenger boat—or, as it is called in Paris, an omnibus boat—built for use on the Seine by the Société des Magasins du Louvre.

In the illustrations fig. 1 is a general view; fig. 2 a longitudinal section; fig. 4 a plan, one-half showing the upper and one-half the lower deck; and fig. 3 is a cross-section.

In designing this boat two objects were kept in view, one being to make a vessel better in its accommodations than the ordinary small steamers used on the river; the second, to make a boat which would, from its model and decorations, be attractive to visitors to the Exposition.

With these aims, the boat was made on fine lines, in order to secure speed; the passenger accommodations were made unusually good, and much care was taken to make the decorations attractive to the eye.

The hull was built by the Société des Forges et Ateliers de St. Denis, and the engines by Boulet & Company.

The dimensions of the boat are as follows:

Length over all	31.00 meters	(101.68 ft.)
Length between perpendiculars	29.00 "	(95.12 ")
Extreme width on deck	5.20 "	(17.06 ")
Depth forward	2.30 "	(7.54 ")
" aft	2.40 "	(7.87 ")
Draft of water forward	1.40 "	(4.59 ")
" " aft	1.70 "	(5.58 ")
Area of immersed cross-section	3.92 sq. m.	(32.20 sq. ft.).

Compound condensing engine:

Diameter of high-pressure cylinder	0.280 meter	(11.02 in.).
" " low-pressure "	0.480 "	(18.90 ")
Stroke of cylinders	0.300 "	(11.81 ")
Revolutions per minute		200
Power developed		100 H. P.

The power is furnished by two multitubular boilers of the Terme & Deharbe type, the working pressure being 140 lbs.

The boat is entirely of iron. The ribs are spaced 19.68 in. apart, and there are five water-tight compartments in the hull.

The city ordinances limit the speed of boats on the Seine to 15 kilometers (9.3 miles) an hour; but this boat has shown itself capable of making a much higher speed.

The pilot is placed on the upper deck, forward of the smoke-stack; this arrangement, almost universal here, is a novelty in France, and is much commended for its convenience. The steersman is usually placed near the stern, and steers by signals from a lookout forward.

The upper deck is covered with an awning and is provided with fixed seats, arranged as shown in fig. 3; the lower deck, or cabin, has upholstered seats running around it. The cabin is provided with steam-pipes for heating in winter.

The boat is lighted with incandescent electric lights, the electric current being furnished by a Breguet continuous current machine, run by a separate engine. There are 24 lights, each of 16-candle power.

The decoration has purposely been kept as low as possible, in order not to interfere with the view from the decks. A mythological group of gilded swans is placed forward, apparently serving to hold up the awning and to support the staircase running to the upper deck. At the after end there is a baldaquin held up by another mythological group of dolphins and sea-nymphs. This ornamentation relieves the severity of the outlines of the boat, and is intended to imitate the decorations placed upon the ancient galleys. The general effect is said to be very agreeable.

The electric lights in various parts of the boat are enclosed in gilded lanterns of Louis XIV. pattern.

For a small boat, used only for very short trips, this seems to be an excellent pattern, although lacking in many of the conveniences we are accustomed to in this country even on our smaller steamboats. The hull and engine are worth examination, and there is something to be said in favor of the economy of space in the passenger arrangements.

This boat is now in service, plying on the Seine between the Bridge des Saints-Peres and the Bridge of Jena, and carrying daily a large number of passengers.

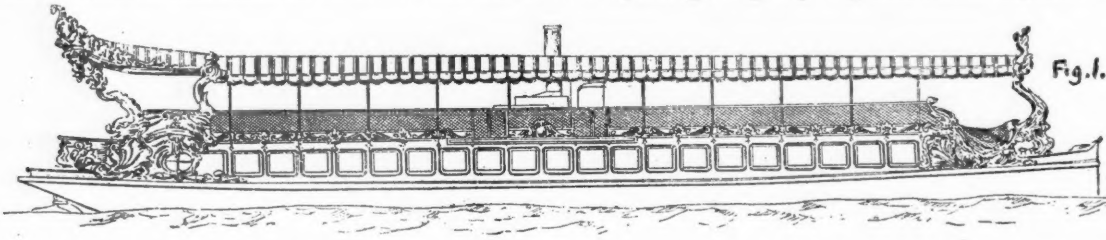
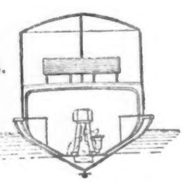


Fig. 1.

Fig. 3.


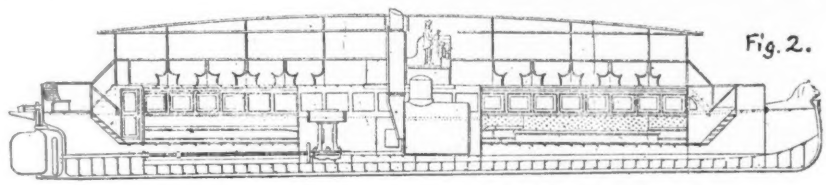


Fig. 2.

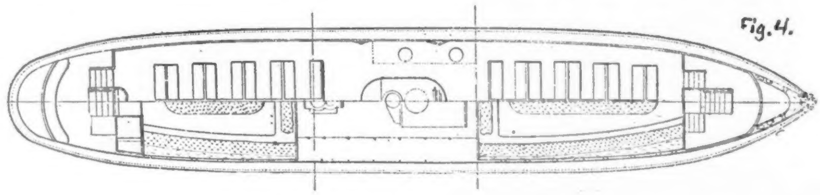
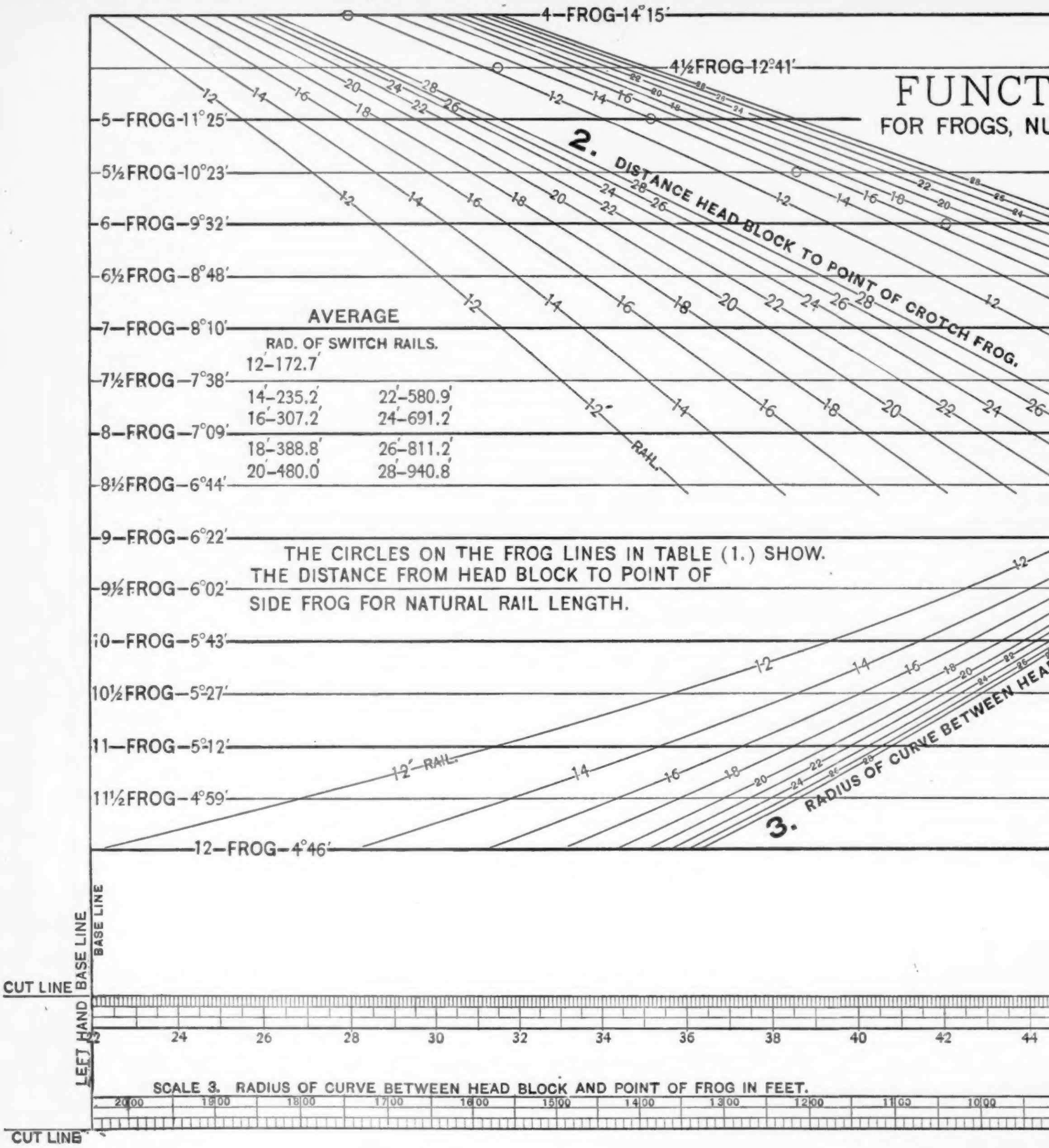


Fig. 4.

ELECTRIC RAILROADS.

[Abstract of paper read by G. W. Mansfield, before the National Electric Light Association.]

TO show the importance of the subject a table is given showing that there are in 26 cities of the United States 189 companies operating street lines; these include the elevated roads in New York and Brooklyn. These companies own 3,414 miles of track; 18,645 cars; 77,884 horses,



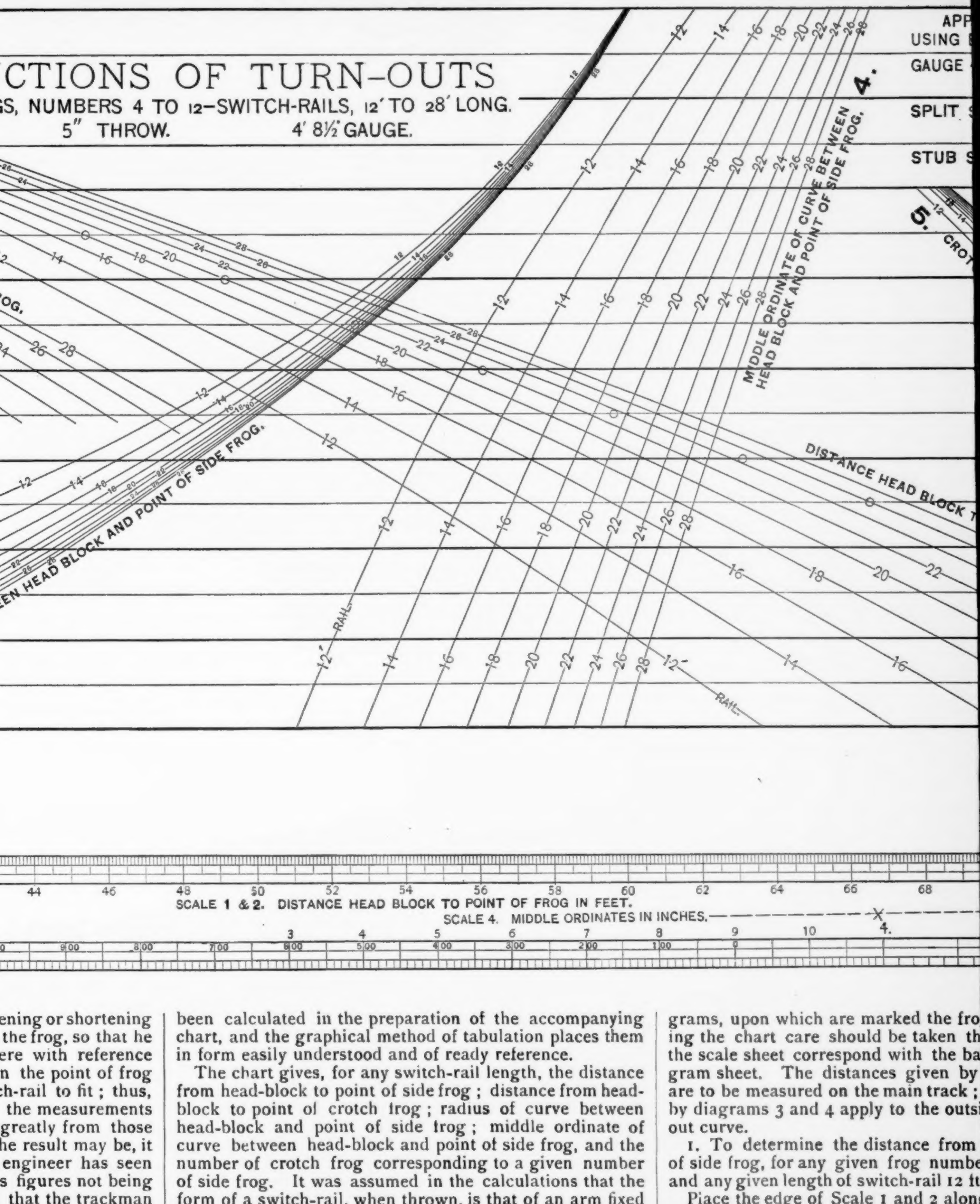
FUNCTIONS OF TURNOUTS.

BY FRANK S. WASHBURN.

THE chart of railroad turnout functions, printed herewith, furnishes a rapid and easy way of obtaining all the measurements necessary to stake out ordinary stub-switch turnouts, single or double, for side frogs numbers 4 to 12, inclusive, and for switch-rail lengths 12 to 28 ft., inclusive. The special value of this chart lies in the fact that it provides for wide variations in the position of the frog with reference to its head-block.

The staking out of a railroad turnout, although ordinarily a simple matter, is the source of interminable disagreements between the young engineer, who depends solely upon his figures for the perfection of his work, and the roadmaster or track-foreman, who depends chiefly upon the accuracy of his eye. It is a subject of discussion in which the man of figures is generally beaten, not because he carries his mathematics too far, but because, by reason of the lengthy calculations involved, he does not carry his mathematics far enough. The engineer deals, ordinarily, with only one length of switch-rail for each size of frog, and hence, for each size of frog, he knows only one distance from heel of switch to point of frog. The trackman, in the course of long experience, has determined with more or less accuracy the effect which lengthening o the switch-rail has upon the position of the fro can, within limits, place a frog anywhere wi to its head-block, lay a curve between the and the head-block, and spike a switch-rail while the turnout may be satisfactory, the m employed in staking it out may vary greatly furnished by the engineer. Whatever the resu is convincing to but one party; the engine failures enough, in consequence of his figur followed, to warrant him in the belief that t is wrong in ever varying from the standard me while, on the other hand, the trackman knows in which he has solved the problem of a troul nection economically and satisfactorily, by tal frog he could pick from stock, and placing it regardless of the standard measurements. Th ful eye and the best-tried rule of thumb, h often fail to get an easy-riding compound cu the heel of switch and the point of frog. But fect switch curves, and occasional derailmer quence of their imperfection, are not suffic tionable to balance the advantage of being a and cities, to lengthen or shorten the regular c heel of switch to point of frog And so a solution of the difficulty is to provide the corr ments for laying out a turnout with the frog p where." So far as the position of the frog of the switch-rail length, all the necessary m can be accurately determined. These measu

(Copyright, 1889, by Frank S. Washburn.)



ening or shortening the frog, so that he ere with reference n the point of frog h-rail to fit; thus, the measurements greatly from those he result may be, it engineer has seen s figures not being that the trackman ard measurements, knows of instances a troublesome con-, by taking the best cing it in the track s. The most skill-mb, however, will und curve between . But even imper-railments in conse-sufficiently objec-being able, in yards gular distance from d so a satisfactory ne correct measure-frog placed "any-e frog is a function sary measurements measurements have been calculated in the preparation of the accompanying chart, and the graphical method of tabulation places them in form easily understood and of ready reference.

The chart gives, for any switch-rail length, the distance from head-block to point of side frog; distance from head-block to point of crotch frog; radius of curve between head-block and point of side frog; middle ordinate of curve between head-block and point of side frog, and the number of crotch frog corresponding to a given number of side frog. It was assumed in the calculations that the form of a switch-rail, when thrown, is that of an arm fixed at one end and deflected 5 in. at the other. The curve between the head-block and the point of frog is taken as the arc of a circle tangent at one end to the curve of the switch-rail and tangent at the other end to the line of the frog. The approximate rules for the laying out of turnouts, contained in the upper right-hand corner of the chart, are given, because they are easily memorized and enable one to be independent of tables in ordinary cases where it is practicable to use the normal length of switch-rail.

USE OF CHART.

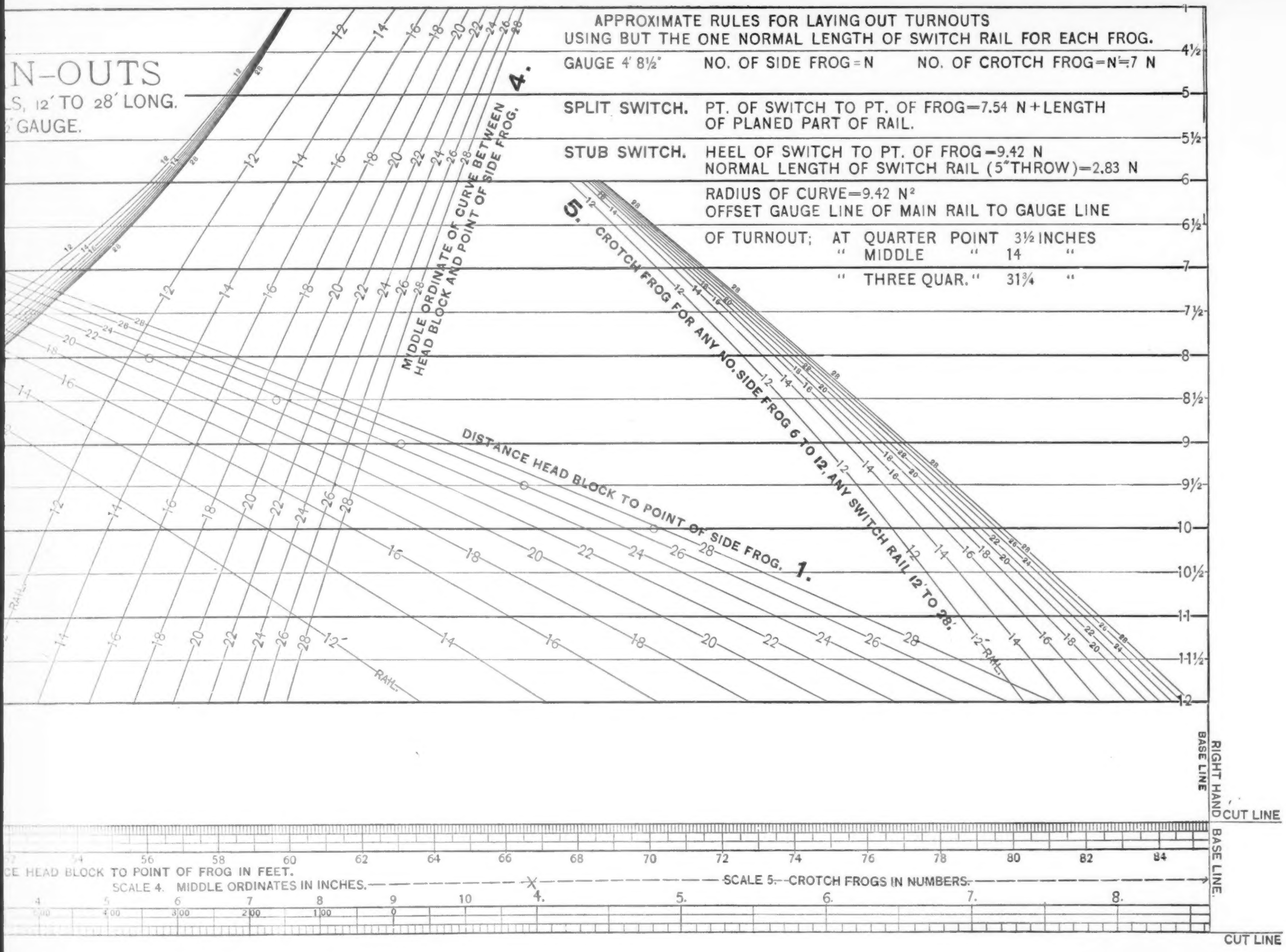
It is first necessary to cut the original chart sheet into two parts, thus separating the scales from the diagrams. The scales should be cut out in one piece, along the two horizontal lines designated as "cut lines." The horizontal ordinates of the diagrams are read by means of the scales, used in the same way as any scale. The vertical ordinates are read by means of the horizontal lines of the diagrams, upon which are marked the fro ing the chart care should be taken th the scale sheet correspond with the ba gram sheet. The distances given by are to be measured on the main track; by diagrams 3 and 4 apply to the outsi out curve.

1. To determine the distance from of side frog, for any given frog numbe and any given length of switch-rail 12 ft.

Place the edge of Scale 1 and 2 along whose number corresponds to the num frog, and read the scale, in feet and ten sects, in Diagram 1, the line whose nu the given length of switch-rail. Diagr near the upper left-hand corner of th lower right-hand corner, and is marke block to point of side frog."

2. To determine the distance from h of crotch frog, for any given crotch fr inclusive, and any given length of swi ft., inclusive:

Place the edge of Scale 1 and 2 along whose number corresponds to the nu crotch frog, and read the scale, in feet it intersects, in Diagram 2, the line wh sponds to the given length of switch-ra tends from the upper left-hand corner o nally half-way across the chart, and is from head-block to point of crotch frog.



n the preparation of the accompanying phical method of tabulation places them erstood and of ready reference.

for any switch-rail length, the distance point of side frog; distance from head-crotch frog; radius of curve between oint of side frog; middle ordinate of ad-block and point of side frog, and the frog corresponding to a given number as assumed in the calculations that the ail, when thrown, is that of an arm fixed leflected 5 in. at the other. The curve -block and the point of frog is taken cle tangent at one end to the curve of d tangent at the other end to the line of pproximate rules for the laying out of d in the upper right-hand corner of the because they are easily memorized and ndependent of tables in ordinary cases able to use the normal length of switch-

USE OF CHART.

sary to cut the original chart sheet into parating the scales from the diagrams. d be cut out in one piece, along the two esignated as "cut lines." The horizontal iagrams are read by means of the scales, e way as any scale. The vertical ordi- means of the horizontal lines of the dia-grams, upon which are marked the frog numbers. In using the chart care should be taken that the base lines of the scale sheet correspond with the base lines of the diagram sheet. The distances given by diagrams 1 and 2 are to be measured on the main track; the distances given by diagrams 3 and 4 apply to the outside rail of the turnout curve.

1. To determine the distance from head-block to point of side frog, for any given frog number 4 to 12, inclusive, and any given length of switch-rail 12 ft. to 28 ft., inclusive:

Place the edge of Scale 1 and 2 along the horizontal line whose number corresponds to the number of the given side frog, and read the scale, in feet and tenths, where it intersects, in Diagram 1, the line whose number corresponds to the given length of switch-rail. Diagram 1 extends from near the upper left-hand corner of the chart to near the lower right-hand corner, and is marked "Distance head-block to point of side frog."

2. To determine the distance from head-block to point of crotch frog, for any given crotch frog number 4 to 8½, inclusive, and any given length of switch-rail 12 ft. to 28 ft., inclusive:

Place the edge of Scale 1 and 2 along the horizontal line whose number corresponds to the number of the given crotch frog, and read the scale, in feet and tenths, where it intersects, in Diagram 2, the line whose number corresponds to the given length of switch-rail. Diagram 2 extends from the upper left-hand corner of the chart diagonally half-way across the chart, and is marked "Distance from head-block to point of crotch frog."

3. To determine the radius of the curve lying between the head-block and the point of side frog, for any given side frog number 4 to 12, inclusive, and any given length of switch-rail 12 ft. to 28 ft., inclusive:

Use Scale 3 with Diagram 3 in the same manner as directed for the use of other scales and diagrams. Scale 3 is on the opposite side of the scale strip from Scales 1 and 2. Diagram 3 extends from near the middle of the top of the chart to the lower left-hand corner, and is marked "Radius of curve between head-block and point of side frog."

4. To determine the middle ordinate of the curve lying between the head-block and point of side frog, for any given side frog number 4 to 12, inclusive, and any given length of switch-rail 12 ft. to 28 ft., inclusive:

Use Scale 4, reading it in inches and tenths, with Diagram 4. Scale 4 is superimposed on the right-hand end of Scale 3. Diagram 4 occupies the middle of the chart, to the right of Diagram 3, and is marked "Middle ordinate of curve between head-block and point of side frog."

5. To determine the number of crotch frog, for any given side frog number 6 to 12, inclusive, and any given length of switch-rail 12 ft. to 28 ft., inclusive:

Use Scale 5, reading it in frog numbers and tenths, with Diagram 5. Scale 5 is on the right of Scale 3 and Scale 4. Diagram 5 extends from the lower right-hand corner diagonally half-way across the chart, and is marked "Crotch frog for any number of side frog 6 to 12, any switch-rail 12 ft. to 28 ft."

Interpolation should be resorted to for odd numbers of frogs or odd lengths of switch-rails.

and 528 locomotives and other motors; they carried last year 1,434,057,595 passengers.

In 1885 there were three electric railroads having $7\frac{1}{2}$ miles of track and 13 cars. The figures on July 1, 1889, were as follows:

	In operation.	Building.	Total.
Electric railroads	19	42	61
Miles of road	113	267	380
Number of cars	174	364	538

This does not include the West End Company, of Boston, which is making arrangements to supply its 1,584 cars with the electric motor.

In meeting the demand for better city transit there are many considerations claiming the careful attention of the electrician. The conditions to be met with are widely different from all other electrical applications. Essentially there is: 1. A steam engine. 2. A dynamo. 3. A conductor. 4. A motor mounted on a vehicle and subjected to mechanical and physical conditions more extreme and severe than have heretofore been imposed upon any electrical machinery. The engine, of course, has to stand the hardest work.

Owing to the nature of the work itself the amount of power called for is very variable. In one instance cards taken at short intervals from an engine running a busy line showed a variation from $15\frac{1}{2}$ to 121 H. P. in the power exerted. Under these circumstances, the question of coal economy is a troublesome one, and, moreover, the amount of repair needed is increased. The larger the road, however, the less the variation will be, comparatively, and the more economically the engine can be run.

Almost the first question asked by the manager of an electric light company when an application has been made to him for power, is: "How much electric power must I allow per car?" No man can give a definite answer to this question that will meet all conditions.

If the following facts are known, a fair judgment can be made: 1. Number of cars simultaneously operated. 2. Speed and nature of service. 3. Maximum grade, and number of grades. 4. Scheduled location of cars in reference to grades. 5. Motor cars to be used to tow other cars or not. 6. Any peculiarities in regard to the distribution of cars. 7. Condition of track. 8. Location of track in reference to power house.

On a portion of the Cambridge Division of the West End Company's road, of Boston, the Thomson-Houston Company's motors commenced running February 16, 1889. Up to July 1, 165,781 miles and 25,505 round trips had been made with a loss of but 325 miles, or 0.19 per cent. (49 round trips). During this time nearly 1,500,000 passengers were carried. This, in view of the fact that during the entire time one, and part of the time two tow-cars were drawn, is remarkable.

On a portion of the route there is an open bridge about 1,800 ft. long, on which is located one draw, which is opened from 20 to 30 times a day. Over this bridge 1,810 cars per day pass, or on the average of one every three-quarters of a minute, and at some portions of the day they run at half-minute intervals. The teaming on this street is also very heavy, necessitating constant stopping. You will see from these figures what the loss of current or a motor burn-out causing delay would mean. The record, however, has been magnificent. As the dynamos are run by the Cambridge Electric Light Company, and are so arranged that the same engines furnish power and lights for their own purposes, as yet only approximate data as to the fuel consumption, etc., has been possible. A few electrical tests have been made. Ammeter and voltmeter readings were taken at the station every 15 minutes, four readings per minute, or at 15 second intervals. This was kept up from 6.30 A.M. to 12.30 A.M. next morning for five days. In all, 1,480 readings were taken. The average of these readings gave, for 12.6 cars in continuous service, 111.6 ampères, 500 volts, or 74.8 H. P. Per car this is 8.8 ampères and 5.9 electrical H. P. The average number of passengers carried was about 58 per round trip. There are now 32 cars in operation, and observations, in so far as they have been taken, show a marked decrease in H. P. per car. At Richmond, Va., some rough tests gave the electrical H. P. required per car at the station as from 4 to 5. On the road at Lafayette, Ill., the figures of Dr. Bell show the remarkably low figure of 2.5 electrical H. P. There are a number of circumstances on this road that would tend to make this figure so low. The cars are smaller than those ordinarily used, and I should judge that there were other circumstances entering into the calculation that would tend to reduce it. However, it well shows, possibly, one extreme in railroading.

The other extreme might be cited in the case of the Lynn Road, Highland Division. Here only one car is in operation. In the course of its route it ascends a hill graded at the rate of 8.7 per cent. for 300 ft., and immediately passes down on the other side. In this case the engine was indicated. Five cards were taken when the car was ascending the grade, the average of which was 52.2 H. P. If we allowed a dynamo efficiency of 90 per cent., this would indicate an electrical horse-power of 47 H. P. This is unquestionably a very extreme and exceptional case. I might add, incidentally, that the car pays handsomely.

At Plymouth, Mass., a road having many heavy grades, the maximum being over 10 per cent., and operating but three electric cars, each with tow-cars, the electrical horse-power at the station per car was approximately 7.72 H. P. On the cars the extremes vary obviously, according to speed, grades, load, etc. It frequently reaches from four to five times the average value during the total time. In Lynn the variation is enormous. In Cambridge the current frequently rises to from 65 to 70 ampères, or about 42 H. P. Especially is this the case on starting You can see from these figures the impossibility of giving the most approximate figures in this direction unless every detail as to operation and conditions is known. I feel, however, that on roads having no grades over 5 per cent., and operating under 10 motor cars, with tow-cars, 15 H. P. per car would be a safe figure for dynamo capacity. On large roads this figure could be reduced to 12 and possibly 10 H. P. per car, while on small three or five-car roads, with heavy grades, 18 or 20 H. P. might not be any too much.

From estimations based upon many figures, I feel certain that a total electrical efficiency of at least 70 per cent. can be obtained, and a total commercial efficiency measured from the indicated horse-power of the engine to the car-wheel horse-power (W. H. P.) of from 45 to 50 per cent. If the road-bed, rolling-stock, and all the electrical apparatus is maintained as it should be, I see no reason why this figure cannot be exceeded.

There is one point which is of vital interest to the managers of electric light companies, and this is how they shall charge the railroad companies for power. I have already shown you that it is an exceedingly difficult thing to estimate upon the requisite power, as the conditions are so fluctuating and so variable. After, however, the question of the amount of power has been settled, the next point to determine is whether they shall charge the railroad company by the hour, by the day, or by the car-mile. We have a large number of roads already hiring power of local companies; all of the methods just mentioned are in use. Upon small roads, where the schedule of the railroad company is such that they have only a few cars running continuously, meeting emergencies by extras, and where the grades are heavy, a satisfactory basis has been to charge so much per day per car, the price ranging all the way from \$3 to \$5, \$6, and even \$7. When the roads are of moderate size, or are subject to many variations and sudden demands on the part of the public for better facilities, or when the line runs to some resort and the main bulk of business lies in picnics, etc., charges on the hour basis is sometimes preferred. This price varies from 15 to 30 cents per hour. On larger systems, where the schedule is definite and fixed, the mileage basis is the preferable by far. The prices on this basis range from two to six cents.

In the East, where coal ranges from \$4 to \$5 per ton, naturally the prices could not compete with the railroads of the natural gas and coal regions, where fuel can be obtained for almost nothing, in some cases for 10 cents per ton.

I would like now to enter a wedge here in favor of the very best of construction. Your own experience has probably dictated that there is no economy if the original con-

struction be put in with either inferior or faulty material or apparatus. It is most important that the overhead construction, the track-circuit, the wiring of the cars, and all other details be as perfect as it is possible for the best skill and brains to make them. If the light companies would require proper and reasonable guarantees in this direction, whenever they do supply power, it would not only be a surety for their own protection, but would be a strong inducement for the very best of construction work. The railroad man should see that it is for his interests, since there is nothing that will consume profits so rapidly as break-downs.

In conclusion, the possibility and economy of combining electric light stations and power plants is urged, especially for smaller cities.

JAPANESE RAILROADS.

As an addition to the table of Japanese railroads published in the September JOURNAL, we give below the amount of the capital of the several companies, with the mileage each is authorized to build :

Company.	Mileage.	Capital.
Nippon Railroad Company	529.00	$20,000,000
Mito Railroad Company	41.35	1,200,000
Ryomo Railroad Company	52.00	1,500,000
Kobu Railroad Company	21.00	900,000
Iyo Railroad Company	4.00	40,000
Hankai Railroad Company	6.21	330,000
Sanyo Railroad Company	302.25	13,000,000
Osaka Railroad Company	37.00	1,800,000
Sanuki Railroad Company	10.00	250,000
Kansei Railroad Company	72.00	3,000,000
Kiushiu Railroad Company	271.23	11,000,000
Total	1,346.04	$53,020,000

In addition to the capital of these companies, the amount of money spent on the Government railroads has been in all about $35,000,000.

Besides the lines actually built or under construction, there are 15 lines projected, for which concessions have not yet been granted. The total length of these projected railroads is about 700 miles, and the proposed capital is about $30,000,000.

In the city of Tokio there are now 15 miles of street railroads. The rails used are of the trough-shaped pattern, weighing 37 lbs. per yard. The rails are laid on longitudinal sleepers and cross-ties ; the gauge of the roads is 4 ft. 6 in. The cars are run at the rate of about 5 miles an hour. On these lines there are 62 cars in use ; they were all built by the John Stephenson Company, of New York.

UNITED STATES NAVAL PROGRESS.

MENTION has heretofore been made of the fact that some of the new guns for the Navy were to be mounted on pneumatic carriages. From the latest number of the *Naval Intelligence* series, issued by the Navy Department, we take the following description of the pneumatic carriage for the 8-in. breech-loading rifled gun, and the accompanying illustration :

In this carriage, designed and built for the Navy Department by the Pneumatic Gun Carriage & Power Company, the gun is mounted in the ordinary manner by its trunnions in bearings formed in a top carriage, A, which hooks under flanges A^1, formed on the top of the slide A^2, and moves horizontally on recoil instead of up an incline, as in carriages of the ordinary hydraulic type. The reason for this is hereinafter explained. At the front the cheeks forming the slide are connected by a transom, A^3, and secured to a bed-plate, B, provided with brackets B^1, in which are pivoted three truck rollers B^2. The rollers have grooves which work over a projection of corresponding shape formed on a circular bed-plate, B^3, which supports the front of the carriage and the weight of the gun when in battery. In the center of this circular plate (which is secured to the deck of the vessel), and also in the bed of the carriage, is formed a bearing, B^4, for a pivot around which the carriage turns. On the circular bed B^3 is a projecting flange, under which the clips B^6 hook to prevent the carriage from lifting The rear end of the carriage is secured to a transom, C, in which are pivoted four truck rollers, two being placed under each cheek of the slide ; these rollers also have grooves which fit over a projection on the circular traversing ring D, provided with a projecting flange for clipping down the rear end of the carriage. To two downward projecting arms E on the top carriage are secured piston-rods and pistons E^1, which work in the pneumatic recoil cylinders E^2. Each recoil cylinder and its cheek are cast in one piece, and the tops of the cylinders are made on a line with the tops of the cheeks, so as not to interfere with the sighting of the gun. These recoil cylinders are supplied with compressed air by a pipe communicating through the pivot with a reservoir and air compressor by pipe G and stationary manifold G^1. The pistons are solid, without packing, and made less in diameter than the bore of the cylinders to allow of a displacement of a portion of the air by the recoil of the gun and pistons, thus forming nearly an equilibrium of pressure on both sides of the pistons at the termination of the recoil. The excess of pressure caused by the different areas of the cylinder on each side of the piston gradually runs the gun into battery, dispensing with the necessity of inclined slides, a matter of great inconvenience in a rolling sea.

This carriage is worked mechanically by means of a small air engine, H, located in the front portion of the carriage and provided with a follow-up stop-motion valve operated by the hand-wheel H^1. The traversing of the carriage is performed by the engine through the medium of reversible clutch-gears operated by the hand-lever H^2, in connection with a worm-gear, shaft, pinion, and rack formed on the inside of the circular traversing ring D. The traverse of the carriage ceases the moment that the turning of the hand-wheel H^1, which controls the valve of the engine, is stopped.

The elevating and depressing of the gun is performed by means of two horizontal bars which are parallel with the slides of the carriage and are connected to the gun by saddles and the elevating band I. These bars are elevated by vertical racks I^1, which work in grooves in the cheeks of the carriage. Into the vertical racks engage pinions carried by horizontal shafts, which are supported by bearings I^2 formed on the cheeks of the carriage, the shafts and pinions being worked by friction worm-gears and reversible clutch-gears operated by the reversing lever K. This gearing is actuated by the air engine, which receives its air supply of compressed air by a communication through the pivot, the manifold M, and pipe M^1. The exhaust is through the pipe M^2. The pivot revolves with the carriage, so as not to derange the pipes in the carriage, while the manifolds are stationary, so as not to derange the pipes leading to the air receivers.

The carriage can be traversed and the gun elevated or depressed by hand, and the operations can be performed simultaneously or singly as may be required, while the engine remains idle. The initial pressure requisite to take up the recoil of the gun varies from 250 to 400 lbs. per square inch.

This carriage has been built by authority of Congress on the recommendation of the Secretary of the Navy (June, 1886). Its weight complete without the gun is about 16,000 lbs., and in future 8-in. carriages the weight is expected to be reduced to 14,000 lbs.

The trial of this carriage took place at the naval proving ground at Annapolis. The gun mounted upon it was an 8-in. B. L., mark II. ; the powder charge was 126 lbs. of Dupont's brown prismatic powder ; the weight of projectile, 250 lbs. ; and the powder pressure obtained on two rounds was 16.17 and 16.79 tons. The weight of the carriage as given by the contractors, including pivot sockets and tracks, is 16,400 lbs. ; the outside dimensions are : length, 7 ft. ; width, 5 ft. The gun was fired at level with the exception of one round at 14° and three other rounds at 5° elevation.

Two deliberate rounds were first fired, and the rapidity test of 10 rounds was then begun. Three rounds were

fired in less than five minutes, when the pinion on the lever of the breech-plug gave way, and the trial was adjourned until the broken part could be replaced. When continued, seven rounds were fired in 8 minutes 16 seconds.

During the trial 20 rounds were fired, and previous to this some 11 rounds had been fired with various charges. At the end of the trial the carriage showed no spread or other signs of distress.

The recoil varied between 23¾ and 24¼ in., the air pressure in cylinders being kept at about 330 lbs. by the continuous action of the air compressors. It was shown that with this carriage the pressure in the recoil cylinders fell 100 lbs. in five minutes when the air compressors were shut off.

The pneumatic loading apparatus worked efficiently, and the training, elevating and pointing of the gun were well accomplished, but could be improved by increased rapidity.

LAUNCH OF THE "PHILADELPHIA."

The naval event of the past month was the launch of the *Philadelphia*, which took place September 7, at the Cramp yard in Philadelphia.

The *Philadelphia* resembles nearly the *Baltimore*, and is an unarmored steel cruiser of 4,400 tons displacement, 335 ft. long, 38½ ft. in width, and 16¼ ft. mean draft. Though without side armor, she has a protective deck, varying in thickness from 4 in. over the engines to 2 in. at the extreme ends, and the coal bunkers are so arranged as to protect the machinery. The ship is divided into numerous water-tight compartments, and has the latest approved arrangements for ventilation, electric light, etc.

She has three masts, provided with fighting tops, carrying mounts for machine guns. The masts will be rigged for fore-and-aft sails, but the sails will not be relied on for motive power, being only sufficient to steady the ship in heavy weather.

The *Philadelphia* has twin screws, each driven by a separate triple-expansion engine, with cylinders 38 in., 56 in. and 86 in. in diameter and 40 in. stroke. The engines are supplied with steam by four boilers, each 14 ft. in diameter and 20 ft. long.

With forced draft the boilers will carry 160 lbs. pressure, and the engines are expected to work up to 10,500 H. P. The guaranteed speed is 19 knots an hour.

There are several auxiliary engines, which will run the pumps, ventilators, dynamos, etc.

The main battery will consist of twelve 6-in. breech-loading rifled guns, two mounted forward, two aft and eight in broadside. The broadside guns will also have a considerable fore-and-aft range. The secondary battery will include a number of smaller rapid-fire and machine guns, and there will be also five torpedo-tubes, mounted two in bow, one aft and two in broadside.

OTHER NEW SHIPS.

None of the bids received for the three 2,000-ton and the two 3,000-ton cruisers came within the requirements of the Navy Department. For the 2,000-ton ships two bids were received, the Bath Iron Works, of Bath, Me., offering to build them for $780,000 each, but requiring two years and six months time instead of two years. The William Cramp & Sons Ship & Engine Building Company, Philadelphia, offered to build the same vessels for $875,000 each. For the 3,000-ton ships only one bid was received, the Cramp Company offering to take them at $1,225,000 each. As the limits set by law were $700,000 and $1,100,000 respectively, none of the bids could be accepted.

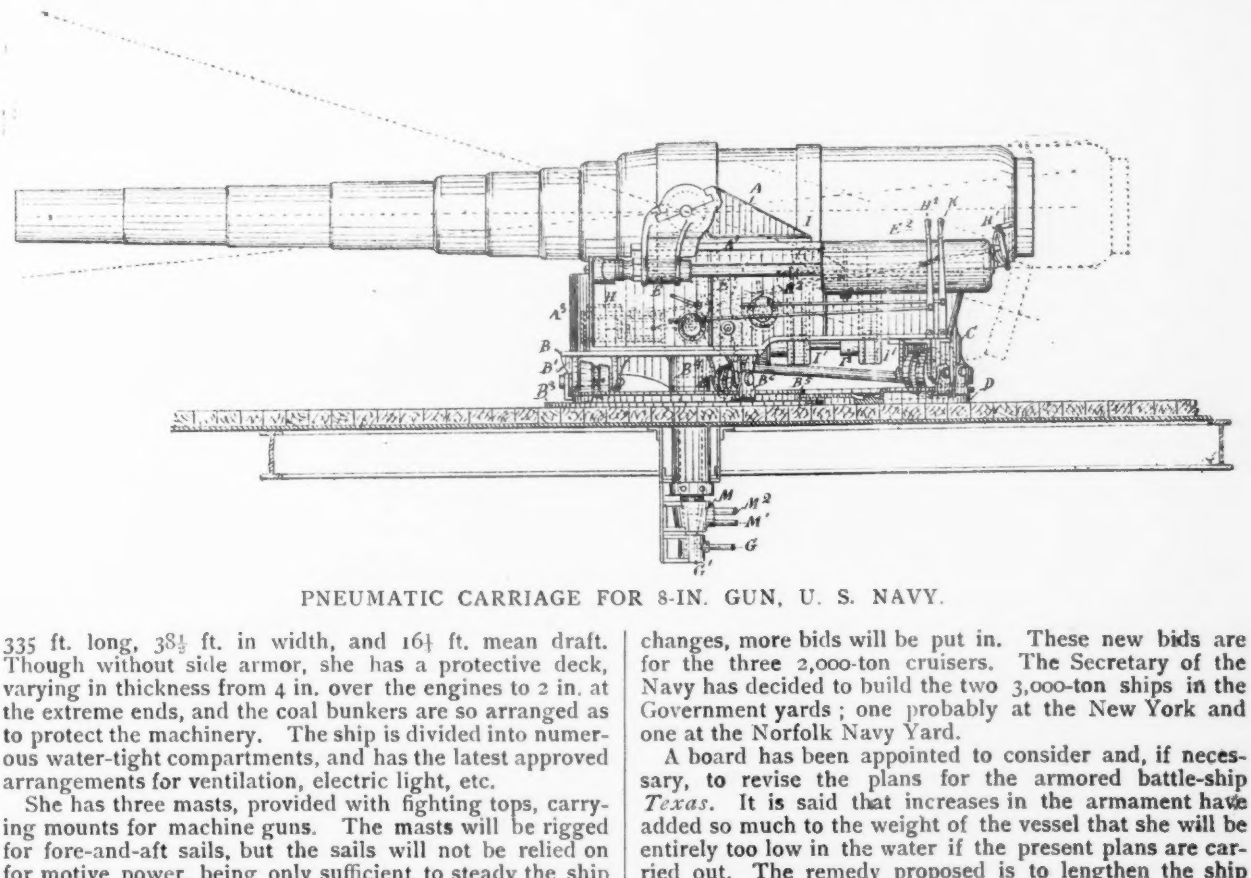
New bids have been called for, and will be received until October 26. In these the conditions are somewhat modified. In the first place, the time is made two years six months instead of two years; the minimum speed has been reduced from 18 to 17 knots an hour, and the ships will not be rejected unless they fall short of 16 knots. There will be a premium of $25,000 for each quarter-knot over the prescribed speed, and a penalty of $10,000 for each quarter-knot below it. It is hoped that, with these changes, more bids will be put in. These new bids are for the three 2,000-ton cruisers. The Secretary of the Navy has decided to build the two 3,000-ton ships in the Government yards; one probably at the New York and one at the Norfolk Navy Yard.

A board has been appointed to consider and, if necessary, to revise the plans for the armored battle-ship *Texas*. It is said that increases in the armament have added so much to the weight of the vessel that she will be entirely too low in the water if the present plans are carried out. The remedy proposed is to lengthen the ship about 30 ft., thus increasing her buoyancy as much as may be needed.

The *Charleston*, on the Pacific Coast, and the *Petrel* in the East have had preliminary trials, both doing very well. Their final trials are yet to come.

The *Yorktown* has been tested pretty thoroughly as to her ability in manœuvring at sea, and also to some extent as a cruiser. The results have been satisfactory. The *Boston* has also been tried in a similar way.

The official speed trials of the new cruiser *Baltimore* took place in Chesapeake Bay September 14. The trials were certainly very thorough, for they took place under somewhat unfavorable conditions of wind and weather, the sea being very rough, high winds blowing at the time, and the water being very rough. Under the terms of the contract, the *Baltimore* was to develop at least 9,000



PNEUMATIC CARRIAGE FOR 8-IN. GUN, U. S. NAVY.

H. P., and the builders were to receive a premium of $100 for every horse-power developed over that figure. The average speed of the *Baltimore* on the four hours' run was 19.8 knots per hour with forced draft, the screw making 110 revolutions a minute, and the boilers carrying an average pressure of 118 lbs. At times the number of revolutions ran up to 112, and the speed was as high as 20.2 knots per hour. The official report has not yet been made, nor have all the calculations made from the indicator diagrams been worked out; but there is no doubt that the *Baltimore* passed the speed trial very successfully, and that her builders will receive a considerable bonus over the contract price. The trials of the ship in turning, steering, etc., were also very successfully passed.

PLANS FOR NEW SHIPS.

The last Congress authorized the building of two large vessels, one of 5,300 tons and one of 7,500 tons displacement. Plans for these ships have been agreed on and submitted for approval.

The 5,300-ton ship will be of steel, 315 ft. long and 50 ft. beam; she will have twin screws and triple-expansion engines capable of working up to 11,000 H. P. She is required to develop a speed of 20 knots an hour. This ship will be a protected cruiser, and will carry a main battery of 10-in. and 12-in. guns, with a formidable secondary battery.

In general design this ship will resemble the famous Spanish cruiser *Reina Regente*, which was described and illustrated in the JOURNAL for December, 1887, page 557.

The larger, or 7,500-ton vessel will be an armored battle-ship of steel, 315 ft. long and 62 ft. beam. She will be built of steel and armored with steel, and will carry a heavy battery, composed of 12-in. and 16-in. guns, with the usual secondary battery. Although so much heavier than the cruiser, her engines are designed to work only up to 10,000 H. P., and the extreme speed will not exceed 17 knots. There will be two triple-expansion engines, driving twin screws. The general design resembles that of the English *Warspite* class.

The authorized cost of the 5,300-ton cruiser is $1,800,000, and of the 7,500-ton battle-ship $3,500,000, both exclusive of armament.

EXPERIENCE WITH METALLIC TIES.

M. MAYER, Chief Engineer of the Western Railroad of Switzerland and the Simplon Railroad, has recently submitted to the Executive Commission of the International Railroad Congress an interesting report on the use of metallic ties, which is translated below. The report is in the form of answers to a schedule of questions sent out by the Commission; for convenience, the questions are omitted in the translation, their nature being sufficiently indicated by the text.

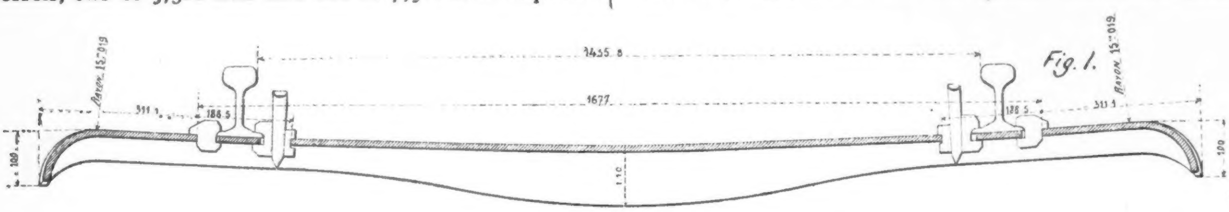
Since 1883 metallic ties have been used on these lines in current practice; that is, a considerable part of the renewals on all sections of the company's system have been made with metal ties.

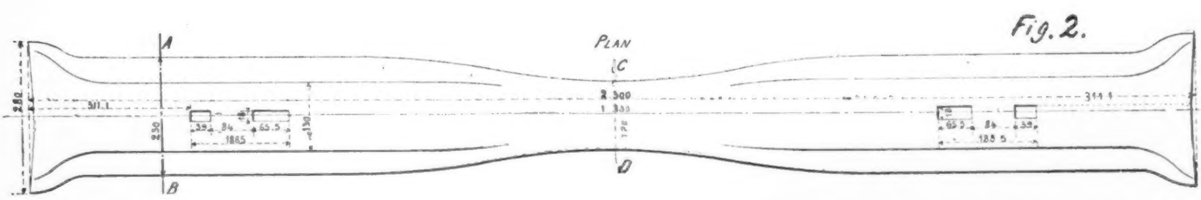
The total length of line thus renewed has been:

	Kilometers.	Miles.
1883	10.867	6.753
1884	17.299	10.750
1885	16.341	10.154
1886	15.341	9.533
1887	21.025	13.065
1888	29.719	18 467
Total	110.592	68.722

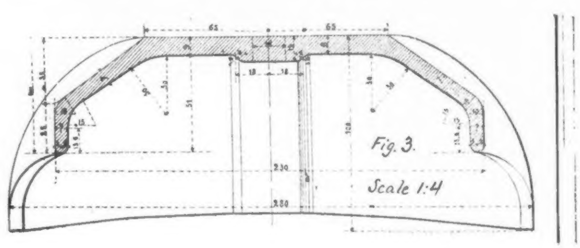
This represents a total of 126,990 metal ties put in the road. The company is continuing the work, and expects to put in these ties at the rate of 25 to 30 kilometers (15 to 19 miles) yearly. Their use is no longer an experiment, but the regular standard of the road.

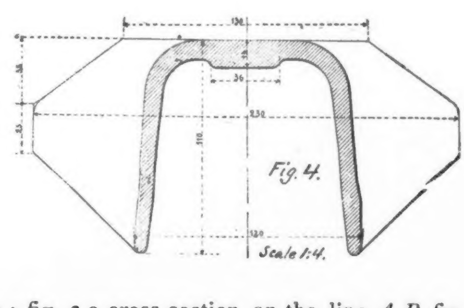
The ties used are of the Hilf system—first introduced on the Berg & Mark Railroad in Germany—with rail-fastenings consisting of clamps and wedges. The pattern now in use was adopted in 1887; it differs from that originally introduced in 1883 in being drawn in at the center and flared out slightly at the ends, the old pattern having been straight for its whole length. The object of the change was to give the tie a better hold on the ballast, and to prevent lateral movement.





The accompanying illustrations show the standard pattern now in use. Fig. 1 is a longitudinal section; fig. 2





a plan; fig. 3 a cross-section on the line *A B*, fig. 2; fig. 4 a cross-section on the line *C D*, fig. 2; and fig. 5 a cross-section of the rail, showing the fastenings.

These ties are all made of homogeneous iron (*Flusseisen*) or of mild steel, having a resistance of from 56,000 to 63,000 lbs. per square inch to breaking; they weigh 45 kg. (99.18 lbs.) each.

As to the conditions to which they are subjected, the grades on the company's lines are in some cases as high as 2.3 per cent. (121.44 ft. per mile); the minimum radius of curvature is 350 meters (1,148 ft.). The traffic, of course, varies on the different branches, the lowest having 8 and the highest 30 trains a day in each direction. The maximum speed is from 28 miles an hour on the less important branches up to 40 miles on the main line from Geneva to Lausanne.

The maximum weight of locomotives is 34 tons, the maximum weight per axle being 12 tons, or 6 tons per wheel. There are a few old four-wheel tank engines in use, which have a weight of 13 tons per axle.

The rails, as shown in fig. 5, are of the flat-footed or Vignoles pattern, the standard rail used on all lines weighing 65 lbs. per yard. Up to 1884 they were made 6 m. (19.68 ft.) long, and seven ties were laid to a rail. Now the rails are all made 12 m. (39.37 ft.) long, and 13 ties—in some cases 14—are laid to a rail.

In most sections gravel ballast is used, the gravel being entirely free from sand or large stones. On some sections, however, broken stone is used for ballast, the standard size being 4 cm. (1.57 in.). By way of trial some ties have been laid on old ballast of gravel and sand.

As to first cost, a section of 12 m. (rail-length) on new oak ties costs at present \$47.05, or say \$1.195 per running foot; with steel ties the cost is \$47.54, or \$1.207 per running foot; the difference being thus very small. This cost is based on the prices paid at the present time, which are about 87 cents each for oak ties; for the iron ties, \$1.16 each, with 15 cents for the rail fastening, making a total of \$1.31 each.

As to the comparative cost of maintaining track with wooden and with metal ties, more experience is needed to determine. However, it may be said that a return made for the year ending with February, 1889, for 43 sections of track, 21 on wooden ties and 22 on metallic ties, showed that the expense of maintaining the track on the metallic ties was slightly less than on the wooden ties.

The company's experience is that the cost of keeping the track in order with metallic ties is generally equal to or a little higher than with wooden ties the first and second year after they are laid; after the second year there is a notable decrease in cost with the iron tie.

As to the life of iron or steel ties, there is not yet experience enough to speak with any degree of certainty. It may be remarked that the iron ties laid in 1883—the first put down on the Western Railroad—do not show any wear of the upper surface, nor any cutting by the rail. A few of the clamps and wedges used in fastening the rails have been taken out, not on account of failure, but because they were considered too light, and were replaced by new ones of better design.

As far as the effect on rolling stock is concerned, no perceptible differences have been noted. In running over the

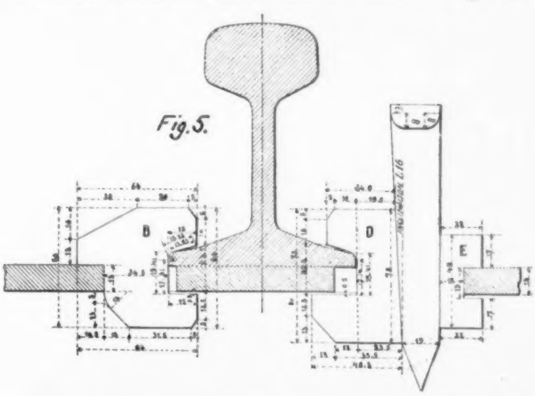


Fig. 5.

iron ties in passenger trains a peculiar metallic sound is heard. It is so slight, however, as hardly to be noticed by any one who is not listening for it carefully.

One of the results noted has been a decrease in the price of oak ties, which has fallen from \$1.25 to 87 cents since the company began to put in metal ties.

It may also be noted that, while sufficient time has not yet passed since the introduction of metal ties on the Western Railroad of Switzerland to determine their average life, of the 126,990 ties laid down since 1883, only 43 ties—or 0.339 per thousand—have been taken out on account of breakage. With the same number of oak ties from 20,000 to 25,000 would have been taken out and replaced by new ones. This is regarded as conclusive in favor of their durability.

The results have been in general so favorable that, as noted above, the company has adopted the metal tie as its standard, and is putting them in on from 25 to 30 km. (15 to 19 miles) a year. Contracts for a supply for five years at this rate have been let.

Statistics furnished by the other Swiss railroads, while they do not give absolutely identical results, are all favorable to the use of metallic ties.

The Central Railroad Company of Switzerland uses ties of the same pattern—Berg & Mark—as the Western Company, but somewhat heavier, weighing 55 kg. (121 lbs.) each. On this road the cost of maintenance of a section 12.9 miles in length, for the third year after the iron ties had been laid, was \$869, as against \$1,563 with wooden ties—a decrease of $44\frac{1}{3}$ per cent.

On the Gothard Railroad iron ties of the same pattern have been in use for five years. The pattern is the same as that described above; those first laid weighed 45 kg. (99 lbs.), but the weight has been increased to 58 kg. (127.8 lbs.). On this road the expenses of maintenance (not renewal) are slightly greater with iron ties. The ballast used is all broken stone.

The Northeastern Railroad of Switzerland has used a large number of iron ties of the Roth-Schuler pattern, the rail being fastened with a chair and bolts; the ties weigh 53.5 kg. (118 lbs.) each. The result has been a marked reduction in cost of maintenance.

Switzerland is a mountain country, where the railroads have numerous heavy grades and sharp curves, where extreme temperatures are experienced and where obstructions from snow are frequent. While in some other countries the traffic may be heavier, this seems to be peculiarly adapted for a thorough and severe test of the metallic tie; and such a test is now being made.

ELECTRIC-LIGHT INSTALLATIONS FOR UNITED STATES CRUISERS.

(Lieutenant T. E. DeWitt Veeder, U. S. N., in *Naval Intelligence*, No. VIII.)

MANY of the difficulties that have been experienced in electric-light installations generally have arisen from the use of inferior materials, the employment of inferior workmen, and, in consequence, inferior workmanship, and to the fact that there have been few, if any, conditions imposed by law looking to the security of the public or the efficiency of the service. The insurance companies for a long time followed—rather than led—the electric-light companies, and even to-day it is not believed that the American underwriters have any special regulations governing the installation of the electric light on board of ships.

All of the new ships have been provided for either in the contracts with the builders or by special appropriation, and the Navy Department is introducing this benefit, so important to the efficiency, health, and comfort of all, into such of the old ships as promise a life-time sufficient to justify the expenditure and a limited appropriation will permit. During the year the installations of the *Yorktown* and *Charleston* have been completed and the *Baltimore* and *Pensacola* well advanced, the work on the latter ship being done from the current appropriation of the Bureau of Navigation, while the others come under the appropriations in lump for the new ships. The contracts for these installations were made with the Edison Company, which likewise has the contracts for the *Philadelphia*, *San Francisco*, *Concord* and *Bennington*. The last two, with the *Yorktown*, are supplied with two generating sets, duplicates, while the *Pensacola* has but one, and the *Baltimore*, *Philadelphia*, *Charleston* and *San Francisco* are to have three each, all of the same pattern.

Congress has also appropriated for electric-light installations for the *Petrel, Vesuvius, Puritan, Monadnock, Miantonomoh, Terror* and *Amphitrite*, as well as for the receiving-ship *Vermont*. Those for the *Petrel, Vesuvius* and *Vermont* should be completed within the present year, and work on the remainder will be commenced as soon as the ships are in condition to receive them.

Much progress has been made in efficiency and security in the ships installed during the past year, the principal of the changes being the adoption of lower-speed machines directly coupled to the engine by means of a flexible coupling, thus avoiding the use of a belt, which is not suited to the conditions existing on shipboard (fig. 1). While the speed of the machines has been reduced to 400 turns, their output per pound of weight has been increased, and they have further been improved in the insulation of their coils and the reduction to a practicable minimum of the heating of the same. The engines used are two-cylinder instead of one-cylinder, as heretofore, giving a better balance and more perfect regulation.

The improved character of the coverings of the conductors, the abolishing of soldered splices with their indifferent and constantly failing insulation, the substitution of substantial water-tight receptacles for portable plugs for the weak and inefficient ones formerly used, the improvement in the design of the water-tight switch and in the molding used, the introduction of incombustible bases for switches, receptacles and cut-outs, the supplanting of the wooden switch-board by one of incombustible material, and the installation of fixtures of excellent quality and suitable design, have all helped to render the system more complete by the elimination of faults either foreseen or already developed by experience.

A higher degree of insulation of the conductors when installed is demanded and obtained, and this can only be brought about by the use of good materials and superior workmanship in doing the wiring. The security from fire and the uninterrupted supply of the current depend upon this work, which is the most expensive part of the installation, and requires a considerable time for its performance. The dynamos and engines may be changed in a moment when worn out, or when, from the advance made in the production of generating sets, it may be deemed wise to replace them; but the wiring as a whole, once properly put in, should never require renewal. It is to an appreciation of these facts that is due the improvement made in its character, until the performance now generally accords with the requirements.

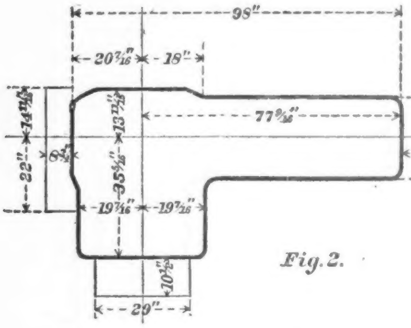


Fig. 2.

Floor space for 100-Ampere generating set.

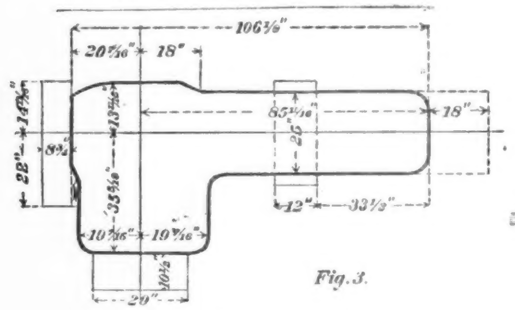


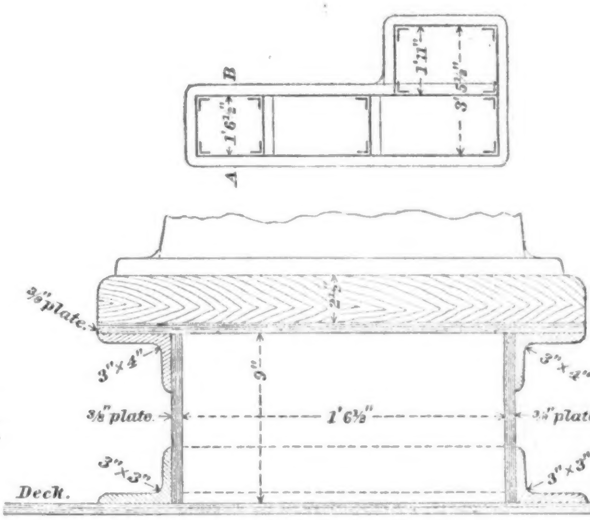
Fig. 3.

Floor space for 200-Ampere generating set.

In describing briefly the character of our installations, the dynamo-room comes first—its location, the arrangement of its contents, and its ventilation; then, following the circuits from the switch-board, the manner in which they are run, the devices employed, and the different sorts of fixtures assigned to fill various offices, will be observed.

The location of the dynamo-room should be made with a view to the security of the machines during time of action and to its close proximity to the steam supply; the importance of the first being apparent, while the second requires but little reflection to appreciate the advantages of dry steam and the absence of the disadvantages attendant upon the conducting of large steam pipes to a considerable distance, and through the holds and fire-rooms of a ship. The space immediately forward of the forward fire-room satisfies the conditions best. Here enough floor space should be assigned, leaving sufficient head-room to afford opportunity for efficient attendance.

Fig. 4



Section at A-B.

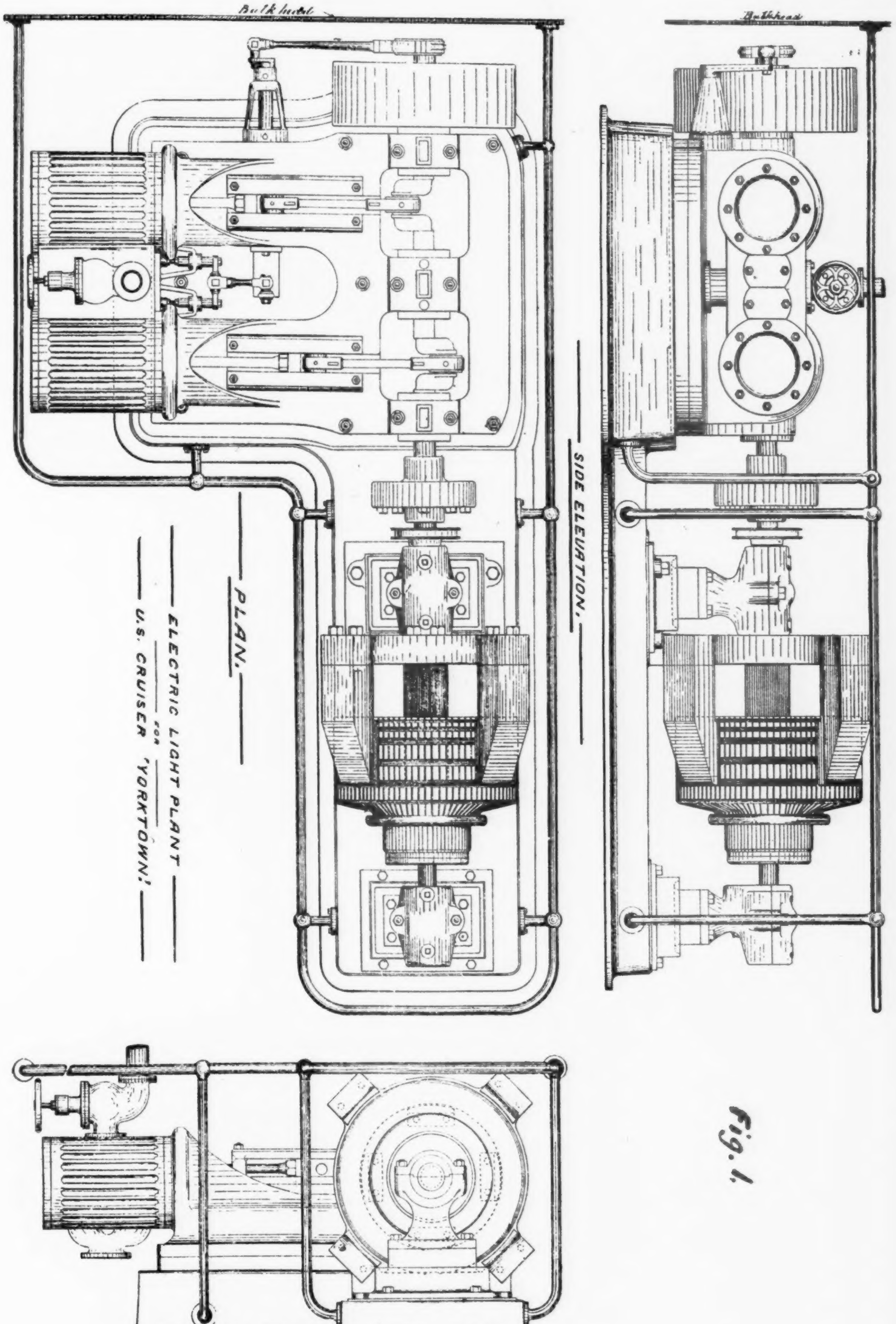
Foundation for 200-Ampere plant.

The spaces required for generating sets composed of Armington & Sims 7 × 5-in. double engines and Edison compound-wound multipolar dynamos, as installed in the *Yorktown* and in the *Baltimore*, are indicated in figs. 2 and 3, the heavy lines showing the outside dimensions of the bed-plates, the additional space in the direction of the length of the armature allowing for its withdrawal, and the laps over the engine end of the plates allowing for the cylinders and fly-wheel.

The bed-plates are set upon light steel foundations, built up 9 in. above the deck, and having on top of the steel cover a 2½-in. white pine floor, which, with a coaming around all sides, is covered with sheet lead to receive such part of the drip as may escape from the oil-way running around the bed-plate. Each plate is securely bolted through its flange and the flange of the foundation. A foundation for an Armington & Sims 7 × 5-in. engine and 200-ampère Edison multipolar dynamo is shown in the sketch with dimensions (fig. 4) This brings the commutators to a convenient height for the adjustment of the brushes.

A comparison of the space occupied and the weights of each of the two sets installed would be extremely unfair to that of 100 ampères, since its engine is, owing to an exigency, of exactly the same size as that used with the 200-ampère machines.

Comparing the weights of the dynamos, 1,841 lbs. and 3,370 lbs., with their outputs shows even then a slight difference in favor of the 200-ampère machine, which might be expected, it giving 4.75 watts per pound to 4.34 watts per pound of the 100-ampère machine.


Bulkhead
Bulkhead
PLAN.
SIDE ELEVATION.
ELECTRIC LIGHT PLANT FOR U.S. CRUISER 'YORKTOWN'.
COMMUTATOR-END ELEVATION.
Fig. 1.

In addition to the spaces required for setting and operating the several generating sets, sufficient room must be allowed for the switch-board, which if practicable should be arranged so that a person may pass behind it, and having a shelf in front carrying the meters, and with the regulator boxes conveniently placed beneath the shelf; if practicable the steam separator and automatic trap should be located in the dynamo-room, and space should further be allowed for oil and waste tanks, and a suitable locker for tools. Preferably the switch-board should be as near as practicable to the commutator ends of the machines. It should be of such dimensions as may be required, and conform in shape to the space assigned it. Every part of it is made of incombustible materials, the board being of slate, the cut-out blocks of porcelain, and the switches being entirely of porcelain and metal.

The wiring of a ship is controlled by the considerations of the reduction to a minimum of the fall in electro-motive force, the probability of a break in a circuit, and danger from fire; there are other considerations, but these are the most important. The first ships installed were wired in the same manner as were houses, and since it is now an admitted fact that the work then done in the latter was hopelessly bad, it can easily be understood that on shipboard, with salt water penetrating nearly everywhere, it required constant attention to keep the lights in operation.

The lights having been assigned, and the sections laid out so as best to carry on the ship's duties and conform to the established routine usages of the service, the sections when brought to the switch-board are arranged, as near as may be practicable, so that the total work to be performed may be halved and each half may be fed separately by its own machine; or, if one machine will suffice to perform the duty at any moment, by means of switches any one of the machines may feed into all of the sections. Each section is controlled by a double pole switch and protected by a double pole cut-out.

A ground detector is attached to each half of the switchboard, a difference in the intensity of the lamps indicating a leak.

Every ship is provided with a testing set for measuring insulation resistances, but this requires the ship to be steady to operate it at all satisfactorily, so that ordinarily at sea no measurements could be taken, and reliance would be placed upon the ground-detector. The volt and ampère meters are made by Siemens, of London; the specifications requiring that they shall contain no permanent magnets nor depend upon the action of gravity. The regulator boxes are made of slate slabs carrying the coils, with brass standards at the corners. A tachometer is belted to the shaft of each armature, and it is proposed also to install a positive motion engine counter, in the readings of which there can be no mistake. A steam gauge and a vacuum or back-pressure gauge are likewise put in. By means of these various instruments, meters, indicators, gauges, ground detectors, etc., the attendant may intelligently carry on his work and not be compelled to guess at the cause of such difficulties as may occur, and with the natural consequences in such cases.

The steam supply is usually by a branch from the pipe supplying the other auxiliaries of the ship. It should have a reducing valve located at a sufficient distance from the engines to allow a steam space in the pipe and separator equal to at least five times the volume of steam used at a stroke by the engines getting steam through the valve. Trouble has been experienced with these valves, but not since they have been put in in this manner. The separator should be placed as near as practicable to the first branch taking steam from the pipe. At each branch of both steam and exhaust pipes a stop-valve is placed for convenience in making repairs. Into the drain from the trap should be carried the drips from the cylinders, and a drain from above the engine stop-valve; also, if the exhaust piping is carried up, it too should be arranged to be drained before starting up.

The dynamo-room, being below the protective deck and without any natural ventilation, should be thoroughly well ventilated artificially, as well as for the good performance of the machines as for the health of the attendants, and for this purpose it is supplied with independent conduits for the exhaust and supply of air and a fan and electric motor, those on the *Yorktown* being connected by a belt. While this latter performs in a fairly satisfactory manner, yet the belt is unnecessary and the arrangement wasteful of space; hence, in the *Baltimore* and other ships it is proposed to wind the armature upon the shaft of the fan. Careful attention to the covering of all steam-piping, cylinders and valve chests aids in keeping down the temperature.

As before stated, the number of lights, with the location of each and the style of fixture to be employed, is determined from a consideration of the duties of the ship and the manner of carrying them on, which considerations also prevail in the arrangement of the lights into sections. It is furthermore desirable that a section main should not exceed in size a No. 6 B. W. G. wire or its equivalent, as a larger one soon becomes very difficult to work; also, where practicable, it is usual to put the lights on the opposite sides of a deck upon different sections, so as to reduce the probability of total darkness. The sections having been laid out, the sizes of the mains, which are the same throughout their length, are calculated according to the rule laid down in the specifications.

The offshoots except to groups are No. 16 B. W. G. The wire used has been of excellent quality, and is known in the trade as the Habirshaw wire. In a test of several wires for use on the *Chicago* its record was the best.

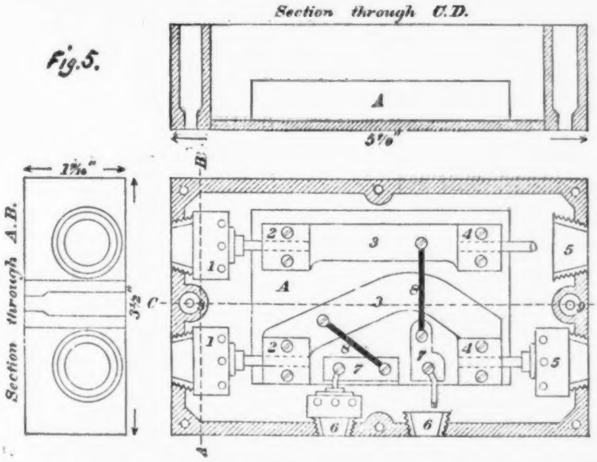
The mains and branches throughout the ship are of lead-covered wire, and are run in wooden molding. The molding is usually of white pine, but of polished hard wood where the wires cross such surfaces. The width of the rib separating the gutters allows of the secure fastening of the molding by means of brass screws without breaking through the sides, and thus sometimes grounding the lead covering of the wire. The thickness of the wood beneath the gutters allows the cutting away of sufficient to let in bolt heads and the like, and still leave half an inch of the wood. The gutters allow $\frac{1}{32}$ in. all around the conductors they are to take, which avoids bruising the lead in putting the wire in. After fitting, the molding is thoroughly covered with white lead paint. Molding should, where practicable, be coped instead of mitred. It has been the practice to cap over only such of the molding as was deemed necessary for the protection of the lead cover from mechanical injury, or where for neatness it was thought desirable, the remainder being uncapped and having the wires held in the gutters by fiber staples. It has been found that in driving these staples injury is sometimes done to the lead covering, and if found necessary to take down the molding, much of the lead cover would be destroyed. It has, therefore, been decided to cap all molding, as the capping offers a better protection, and with the disappearance in our work of underwriters' and other inferior insulations, it is not so important that every conductor should be in sight. The present insulation is good, and being further protected from water by the lead covering, it is reasonable to presume that the continuity of the conductors will not be broken by the attacks of salt water, and in consequence there is little danger to be apprehended. Other improvements in installations for the detection of leaks and for the measurement of resistances, give the officer in charge better opportunities than formerly to know the condition of the circuits. The objection to the use of capping is founded upon the same basis as the objection to lead-covered wire—*i.e.*, poor materials and poor workmanship.

Where conductors pass through beams, bulkheads and the like, the openings are lined with hard rubber tubing; in passing through decks and water-tight bulkheads, stuffing-boxes prevent the passage of water.

From a section-switch in the dynamo-room to the point where a branch is to be taken off for a light, unbroken lengths of wire are run; a junction-box (fig. 5) is here introduced, the wires from the switch-board entering through the stuffing-boxes 1 1, and being firmly bound beneath the caps 2 2 by means of screws. The junction strips 3 3 have also binding clamps 4 4 at the opposite ends, from which point the mains continue on, issuing through the stuffing-boxes 5 5, and continuing unbroken as before to the next point where a branch is to be run, where another junction-box is introduced. The branch wires enter by the stuffing-

boxes 6 6 and are taken to the binding posts 7 7. Between these posts and the pieces 3 3 are placed the fuses 8 8. Fuses are required to be at least 1¼ in. long, and are introduced at every change in the size of a conductor. All of the metal in the box in circuit is carried upon the block *A*, which may be of porcelain or other suitable incombustible material. The wells 9 9 take the screws which fasten the box in its place; these and the stuffing-boxes are put inside the junction-box merely to reduce the work of fitting the latter in place. The cover of the box is lined with rubber

Fig. 5.



cloth, which, besides packing the edges of the box, packs the screw wells also. The branch wires are carried to the point at which the light is to be placed, sufficient end being left to wire the fixture, thus avoiding a splice. In order to carry two No. 16 wires into a socket it is necessary to have the entrance in the base considerably enlarged.

All fixtures having keyless sockets, except the special wire-guard fixtures, have switches which may be water-tight or not, depending upon the location. The one-light switches are single pole, the parts in circuit being carried upon a block of similar material to that used in the junction-box; the water-tight switches being rendered so by inclosing the block carrying the switch in a water-tight bronze box, the wire entering and issuing through stuffing-boxes, the switch being operated by a key through the cover of the box, the stem of the key having a stuffing-box properly packed.

The water-tight receptacle for portable plugs consists of a bronze box having in the bottom a porcelain block carrying the necessary fittings for a wedge-shaped plug, the wires passing out through stuffing-boxes. The cover is hinged and closed by a catch, the inside of the cover being lined with rubber cloth to pack the edges, and the portable cord being wrapped so as to pack itself as it lies in a recess between the cover and the side of the box.

The switches and receptacles not water-tight are not peculiar to the service, so need not be described; but the growing and almost general use in this country of incombustible materials only, in switches, plug receptacles, cut-outs, regulator boxes, and switch-boards, and the possibility of obtaining such articles in the market, must be attributed to the requirements of the Navy Department in the installations put in under its direction.

Not only is it required that the circuits shall have a high insulation resistance, but the lead cover of the conductors, the junction, switch and receptacle boxes, and fixtures must all have half an inch of wood, at least, between them and outside metallic contact.

The fixtures have been much improved during the past year, more particularly in strength and finish. The special wire-guard fixture is the one generally employed, being adapted for fastening upon vertical surfaces. The board is made 2 in. thick to allow for cutting out at the back to let in bolt-heads and the like. The reflector is a corrugated-glass mirror; the lamp is inclosed in a steam-tight globe, the cover of which is supported by a goose-neck soldered into the switch-box. The branch wires enter the switch-box through stuffing-boxes, the lead cover being stripped after it enters the packing; a special quality of fixture wire carries the current from the switch to the socket. The switch is of the same sort as that already described.

The coal-bunker fixture resembles the last, but differs in having its switch located at a convenient point outside the bunker and having a larger and heavier guard with smaller meshes. The branch wires pass directly into the socket through stuffing-boxes in the cover to the steam-tight globe, the lead as in all other cases being stripped in the packing.

For lights upon the ceiling generally, the ordinary steam-tight globe fixture is employed, the branch wires passing through stuffing-boxes in the cover of the globe. At the water glasses in the fire-rooms and where necessary these fixtures are protected by a light metal guard or cage.

The state-room and office fixtures are supplied with a cord of sufficient length to permit their use in any part of the room.

The portables supplied for use in holes, boilers, double bottoms and similar places are provided with enough cord for the purpose, and are light and not easily injured.

Cabin and ward-room countries are fitted with electroliers or ceiling fixtures, the kind depending somewhat upon the height of the ceiling.

The running lanterns contain two 16 candle-power lamps supported from the top of the lantern, which is made thoroughly water-tight, the flexible cords passing out through stuffing-boxes, each plug going to its own receptacle. The lens heretofore employed is still used, the lamps being placed as advantageously as practicable and having a reflector behind them.

Other special fixtures are sometimes used as well as the ordinary bracket, pendant, etc., such as are installed on shore.

No satisfactory finish for fixtures has yet been obtained, everything yielding to the attacks of salt air and salt water. Nickel has been tried several times, but in each instance with very unsatisfactory results. At present bronze is used without any coloring, except in certain of the fixtures in cabins and ward-rooms, which are treated with acid.

Trouble has been experienced with the insulating parts of sockets and the ratchet-wheel of the one-light switches; these parts were made of fiber and also of other materials of unknown composition and brief lifetime, and it has been found necessary to reject all of them, as they take up moisture, and upon drying become distorted or disintegrate. Lava will probably be used in their stead.

All lamps are of 80 volts, and require 4 watts to the candle-power. They are of 10, 16, 32 or 50 candle-power each. Having adopted lamps of these dimensions as standard, and having in view the adoption of a standard socket and standard fixtures, ships abroad will be enabled to transfer stores to each other, which has not heretofore been practicable.

The ships as now installed are liberally fitted out, and with intelligent supervision and attendance, and the absolute prohibition of meddling with any part of the circuits, lamps, etc., by those not authorized, there need be little trouble anticipated. The tendency of thoughtless persons is to waste in using light when not required. A lamp used unnecessarily is not only consuming its guaranteed life, but fuel is wasted. The cost of lamps is an important item, and while this method of illumination is expected to promote health and comfort among the ship's company, extravagance is apt to occur and should be guarded against. An old lamp, having lost a part of its power, may still be of service in store-rooms and other places where such a light would suffice. Care should be taken to clean daily the lamps, globes and shades, if the best effect would be produced for the power expended.

Some trouble and inconvenience would be saved if the circuit be broken upon putting in or taking out of circuit a lamp or a portable plug. Neglect of this often causes the melting of the fuse, with the delay in consequence necessary for its renewal.

Junction and switch-boxes not properly closed are often found to be the cause of "bad" ground. Careful, steady men should be selected to operate the plant. Attention to

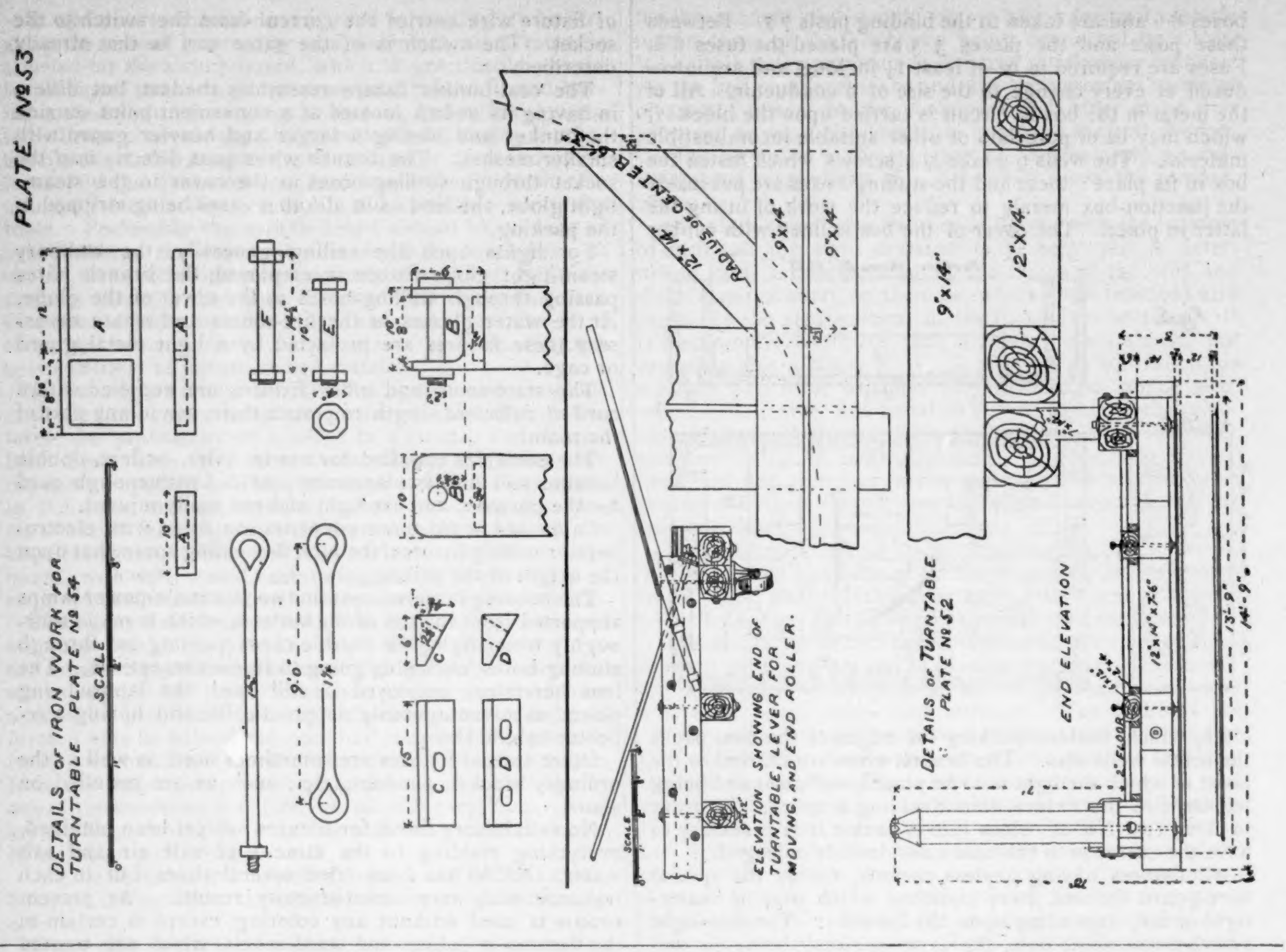
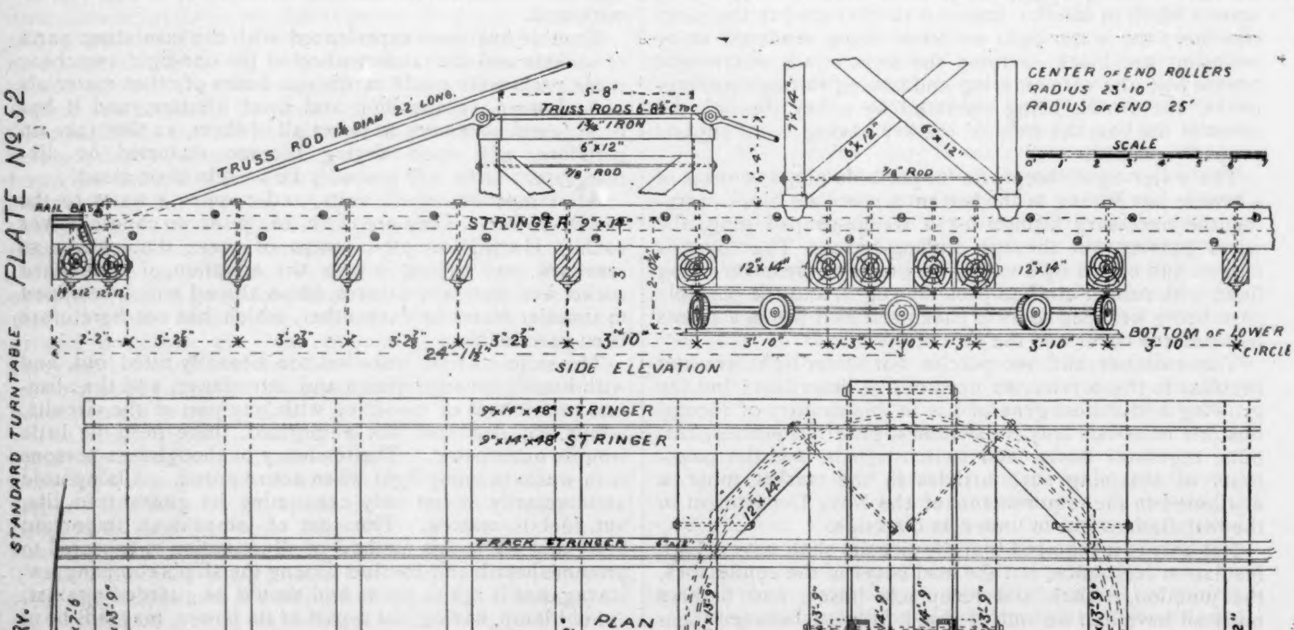


PLATE No. 53
DETAILS OF IRON WORK FOR TURNTABLE PLATE No. 54.
SCALE
RADIUS OF CENTER RAIL
12"x 14"
9"x 14"
12"x 14"
ELEVATION SHOWING END OF TURNTABLE, LEVER FOR MOVING, AND END ROLLER.
DETAILS OF TURNTABLE PLATE No. 52
END ELEVATION
FLOOR


NEW BRUNSWICK RY. STANDARD TURNTABLE
PLATE No. 52
TRUSS ROD 1⅛" DIAM 22' LONG.
TRUSS RODS
1⅛" IRON
6"x 12"
⅞" ROD
RAIL BASE
STRINGER 9"x 14"
CENTER OF END ROLLERS RADIUS 23' 10"
RADIUS OF END 25'
SCALE
12"x 14"
BOTTOM OF LOWER CIRCLE
24'-1½"
SIDE ELEVATION
9"x 14"x 48' STRINGER
9"x 14"x 48' STRINGER
TRACK STRINGER
PLAN
9"x 12"
TRACK STRINGER
9"x 14"x 48' STRINGER
9"x 14 x 48' STRINGER

seeming trifles will keep everything in order and diminish accidents, which in most cases are caused simply by neglect. Attendants who have had little experience are usually afraid of the machine, or they feel that they have acquired about all that is worth knowing; of the two, the uncertain man is to be preferred, as he will in time acquire confidence; but the latter will often cause trouble by meddlesome acts, the consequences of which he is not wise enough to foresee. A favorite place for the operations of these is the commutator, which, if they are not checked, would soon be worn away by frequent dressing down with the file. This should be prohibited by the officer in charge of the machines, who should allow neither file nor sandpaper to touch the commutators except by his directions. The expenditure in brushes should be watched, as these are likely to be worn away more under the file than on the machines. With everything in working order and an intelligent set of attendants it should not require more than 15 minutes per day of the time of the officer having charge of the installation.

THE USE OF WOOD IN RAILROAD STRUCTURES.

By Charles Davis Jameson, C. E.

(*Continued from page* 425.)

CHAPTER XIV.

TURN-TABLES.

PLATE 52 shows plan, elevation, and some details of the Standard Turn-table of the New Brunswick Railroad.

The distinctive feature of this form of table is the large center-bearing given it by means of the inner circle and rollers, and in this also consists the principal defect in the table, particularly at the present time. If, when the locomotive is run upon the table, great care is used to exactly balance it over the center, so that an equal weight comes upon all the center wheels, the table works in a most satisfactory manner. But to effect this equality of bearing requires much care and a nicety in the handling of the locomotive that consumes too much time. When the locomotive is not balanced, however, most of the weight being thrown upon the wheels on one side, causes those wheels to bind and thus interferes greatly in the manipulation of the table. As the wheels are carried toward the center, this weight has also a tendency to force the wheels out and often to such an extent as to break them, and result in an accident. With the comparatively light locomotives used in years passed this defect was not so noticeable, and owing to the simplicity of construction this style of table has been very generally used until within the last few years.

The form of trussing used, by means of which this table is rendered stiff, is exceedingly simple, and where large timber can be easily procured for the chord pieces (as is the case on the New Brunswick Railroad) is cheap. But owing to the lack of support between the ends and the inner circle, exceedingly heavy chord timbers are necessary in order to give the requisite stiffness. The trussing being only 6 ft. 4 in. high renders all lateral bracing impossible. This, however, is a matter of secondary importance in a turn-table, as owing to the low speed of the locomotive very little shock is felt, and when care is taken in the framing sufficient lateral stiffness is obtained.

Plate 53 shows the end elevation and detail of the center framing of the turn-table shown in Plate 54.

Plate No. 54 shows plans and elevations of the Standard Turn-table used upon the Chicago, Rock Island & Pacific Railroad, the details of the iron-work being shown in Plate 53. In this style of turn-table are remedied two of the defects that exist in the turn-table shown in Plate 52.

1. The inner circle of rollers is done away with and all the weight possible is thrown upon this center bearing. This center bearing consists simply of a chilled pivot that turns on a washer in the bottom of a socket in the lower casting. This socket is kept filled with oil and the washer is replaced whenever it becomes so much worn as to throw too much weight upon the end rollers.

This arrangement obviates entirely the objections arising from an inner circle of rollers, and makes it of less importance that the locomotive should be perfectly balanced on the center.

2. The chord pieces are supported not only at the ends upon the rollers and at the center, but at a point midway between the center and ends by means of a tie rod. This point of the chords being subjected to the greatest strain, must either be well supported or the chord must be of sufficient size to be stiff enough in itself, as is the case in the turn-table, Plate 52. In this style of table the gallows-frame is of sufficient height to allow of lateral bracing.

In many cases the gallows-frame is carried to a sufficient height to do away with the long, inclined truss at each side. To do this, however, requires longer timber, and some form of double portal bracing should be used. Some form of these iron and wood turn-tables will always be used upon roads where wood is cheap and the table not in constant use. At all terminal stations, however, or stations where there are large repair shops, some form of iron turntable is in every way preferable. The turn-table shown in Plate 54, as constructed by the Chicago, Rock Island & Pacific Railroad, costs about $700, while the iron turntable, as built by Sellers, of Philadelphia, costs in place from $1,000 to $1,200.

The following are the bills of material for the two turntables shown in the plates:

No. 31. Bill of Material for Turn-Table. Plate 52.

Wood.

4 pieces 9 in. × 14 in. × 48 ft.
8 pieces 9 in. × 12 in. × 13 ft. 9 in.
2 pieces 12 in. × 12 in. × 13 ft. 9 in.
2 pieces 12 in. × 14 in. × 7 ft. 6 in.
4 pieces 14 in. × 14 in. × 13 ft. 9 in.
2 pieces 14 in. × 14 in. × 14 ft. 9 in.
4 pieces 12 in. × 14 in. × 10 ft.
4 pieces 7 in. × 14 in. × 5 ft. 3 in.
4 pieces 6 in. × 12 in. × 7 ft. 6 in.
2 pieces 6 in. × 12 in. × 5 ft. 8 in.
2 pieces 6 in. × 12 in. × 50 ft.
300 lin. ft. 2 in. × 4 in.
466 ft. B. M. 2 in. flooring.

Iron.

4 rods 1¾ in. × 22 ft. center of eye to end of rod. Rod to have 1¾ in. eye at one end and nut and washer at the other; the ends to be upset for the thread.
2 rods 1¾ in. × 6 ft. 8½ in. from center to center of eyes. Rod to have eyes at each end.
2 rods, ⅞ in. × 7 ft. head, nut and washers.
4 castings for foot of posts.
4 castings for top of posts.
2 castings for center bearings.
8 16-in. wheels for center.
4 rollers for ends.
20 bolts 1 in. × 28 in., head, nut and washers.
70 bolts ¾ in. × 22 in., head, nut and washers.
12 bolts 1 in. × 30 in., head, nut and washers.
20 bolts ¾ in. × 20 in., head, nut and washers.
4 bolts 1 in. × 53 in., head, nut and washers.
4 bolts 1 in. × 24 in., head, nut and washers.
2 bolts 1 in. × 39 in., head, nut and washers.
4 bolts ¾ in. × 24 in., head, nut and washers.

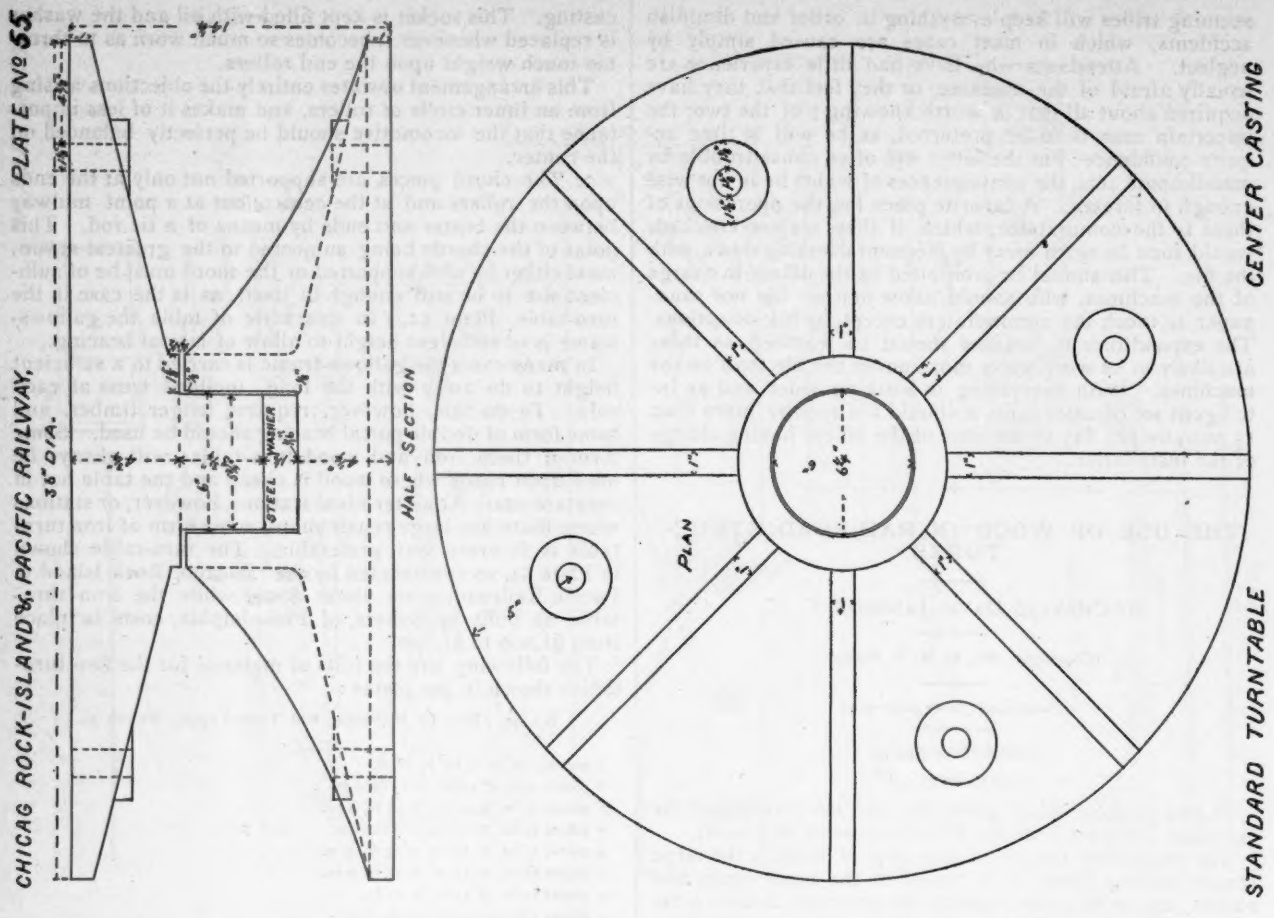
No. 32. Bill of Material for Chicago, Rock Island & Pacific Turn-Table. Plates 53 and 54.

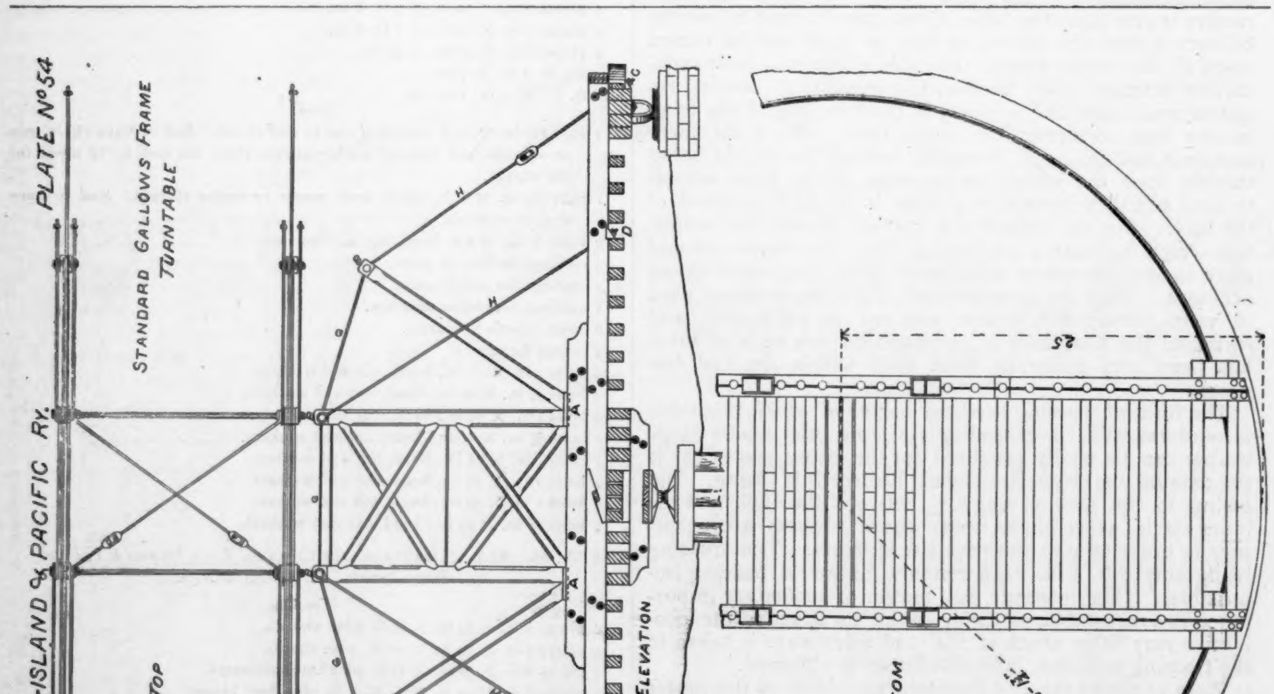
Wood.

8 pieces 7 in. × 14 in. × 26 ft. pine chords.
4 pieces 7 in. × 14 in. × 20 ft. pine chords.
6 pieces 8 in. × 16 in. × 18 ft. pine track stringers.
16 pieces 6 in. × 12 in. × 14 ft. 6 in. pine floor beams.
10 pieces 8 in. × 16 in. × 14 ft. 6 in. pine floor beams.
2 pieces 12 in. × 16 in. × 14 ft. 6 in. pine end floor beams.
3 pieces 12 in. × 14 in. × 10 ft. pine bolsters.
8 pieces 10 in. × 10 in. × 14 ft. pine gallows-frame.
8 pieces 5 in. × 8 in. × 10 ft. 6 in. pine gallows-frame braces.

Iron.

4 eye-bars 1¾ in. × 17 ft. 6 in. from center of eye to end of rod (*H*).
8 eye-bars 1½ in. × 20 ft. 1½ in. from center of eye to end of rod (*H*).
14 eye-bars 1¾ in. × 9 ft. from center to center of eye (*G*).
2 rods 1 in. × 15 ft., with swivel and eye on each end.


CHICAGO ROCK-ISLAND & PACIFIC RAILWAY.
PLATE No 55
STANDARD TURNTABLE CENTER CASTING
HALF SECTION
PLAN
STEEL
38" DIA.


CHICAGO ROCK-ISLAND & PACIFIC RY.
PLATE No 54
STANDARD GALLOWS FRAME TURNTABLE
PLAN OF TOP
SIDE ELEVATION
PLAN OF BOTTOM

3 truss rods for center timbers, 1½ × 15 ft.
4 castings as per detail *A*.
8 castings as per detail *B*.
4 castings as per detail *C*.
4 castings as per detail *D*.
4 2-in. pins as per detail *E*.
4 2-in. pins as per detail *F*.
2 center castings.
4 truck wheels and boxing.
32 bolts ¾ in. × 18 in.
4 bolts 1 in. × 10 ft. 1½ in.
20 bolts 1 in. × 46½ in.
8 bolts 1 in. × 42½ in.
4 bolts 1 in. × 35⅛ in.
16 bolts 1 in. × 32⅝ in.
32 bolts 1 in. × 28½ in.
168 1-in. cast washers.
64 ¾-in. cast washers.

The truss-rods for the center timbers are to be bent as follows: At points 1 ft. each side of the center bend the rods until their extremities are 14 ft. 6 in. apart, and are 22 in. from a straight line drawn through the original position of the rod.

This bill of material includes only the material needed in the construction of the table proper, and does not include rails, guard-rails, material for building the pit, etc.

CHAPTER XV.

PILES AND PILE-DRIVING.

Among the first points to be considered in driving piles is the thickness and character of the different strata through which they have to be driven; also the depth below the surface at which strata of sufficient firmness to support them can be reached. These are the principal points that have to be taken into account where piles are driven for the purpose of supporting any superincumbent weight.

There are two methods of forcing piles into the ground. One, which has been used thousands of years, and until very recently was the only method, is that of forcing them into the ground by means of blows or impact of some kind. The second method, which is of comparatively modern date, and can only be applied economically under particular circumstances, is that of *screwing* them into the ground, the point of the pile being furnished with a large metal screw point, and a rotary motion given to it by means of levers or other suitable mechanism.

The object of the use of piles is to replace loose, unstable ground with something that is firm, solid, and capable of bearing with safety all the weight that of necessity comes upon it. Piles are used either to support a superincumbent weight, as when they are driven to form the foundations of buildings, piers, retaining walls, etc.; or they are used in the form of sheet-piling, to support banks of earth or loose material, something in the form of a retaining wall. They are frequently used as sheet-piling to support the sides of excavations for foundations of buildings, piers, or abutments, or in excavating deep trenches through material which is not sufficiently firm to hold itself vertical during the time of excavation. For the first object—that is, serving as the foundation for a building or piece of masonry—it is very necessary that the piles should penetrate to solid ground or solid rock, if possible. Very often there is not enough attention paid to this fact. One reason for this lack of attention is, that as the pile is driven lower and lower, at last a point is reached where it sinks very little after each blow of the hammer, and it is very apt to be considered that when the pile has reached this point it has sufficient solidity to bear the required weight. But one great cause of the slight penetration of the pile after it has been driven to a certain extent is the increased amount of friction between its sides and the material through which it passes. The amount of this friction depends to a certain extent upon the class of material. In the case of sand, it is almost as impossible to drive a pile any distance through it as it is through solid rock, and in gravel the difficulty increases the finer it gets. That is, starting with sand, the difficulty experienced in driving piles is almost inversely as the size of the particles of which the material is composed.

Another thing to be remembered in driving piles to a secure foundation, is the difference between the ultimate load that is to rest on them and the quick blow of impact which is given them in driving. It is an established fact in mechanics, and also in practice, that a permanent load resting upon a pile will eventually have nearly ten times as much effect upon it as that same load brought quickly upon it and as quickly removed. So that although the pile may penetrate a very little distance from each blow of the hammer, and the weight of the hammer multiplied by the velocity which it has at the time of impact may give a blow that in pounds is much greater than any weight that will come on it from its permanent load, still, after the permanent load has been resting some time upon the pile we very often see examples where it begins to yield, the foundation sinks, and as in very few cases it sinks with regularity over its whole surface, the result is that, if the superincumbent load consists of masonry, one part sinks while the other does not, and there is a crack or fracture in the masonry. There have been cases where none of the piles in a foundation were driven sufficiently far, so that when the masonry was built upon them, the whole foundation sank with perfect uniformity. This, in itself, was not of much consequence, particularly if the structure resting upon the masonry was not an arch. In case it was a masonry arch, it became broken. Wherever there is any doubt about the foundation, and where there is any probability that it will yield to the weight of the piers upon it, it is always better to span the opening by means of a girder rather than a masonry arch, for the reason that the sinking of one end of a girder, up to a certain amount, is of comparatively little consequence. In case the opening is spanned by a metal arch, among many other advantages of using what is called a hinged joint is the one that, if the foundation yields slightly, it does not in any way affect the arch, as owing to the hinge the arch can accommodate itself to the new circumstances.

Where piling is to be done to any great extent, and there is great doubt as to the distance the piles will have to be driven in order to encounter a firm foundation, the material should be tested, either by boring until solid material is encountered, or by driving what are called test piles. But even where the greatest care has been used, there have been numerous examples where the character of the ground changed so much within a comparatively short distance that these borings and test piles were of absolutely no use in the subsequent work.

In regard to the timber for piles, hemlock, pine and spruce constitute the principal timber that is used in this country. Of course the piles should be as straight as possible, and where they are to be used under water should be stripped of their bark and used in the green state. The great danger from driving piles is the splitting of the pile, and the necessity of extracting it or sawing it off and driving another one near it. Any one who has had any experience in pile-driving will appreciate at once the great difficulty of pulling piles. It is almost impossible in ordinary work, but where the work is carried on in tide-water, a very convenient way is to lash the pile very tightly to two timbers at low water that rest upon scows, and when the tide rises the force of the water itself will very often raise the pile.

Where piles are used entirely under water, so that they are kept wet all the time, they will last almost any length of time, provided they are not subject to the attacks of the *teredo navalis*, or pile-worm. This pest is only encountered in salt water, and in greater quantities the nearer we approach the equator. It works between high and low water, and in a very short time cuts the piles off. A great many different remedies have been tried to withstand the attacks of this worm. The creosoting process is probably the most successful of any of the chemical treatments to which wood has been subjected for this purpose. A very good method, although expensive, is to sheathe the piles entirely with copper, which, of course, withstands the sea-water and the attack of the *teredo*. This trouble of using wooden piles in salt water has led to the very extensive use of iron piles. This subject of iron piles will be taken up later.

Where the timber is too large to be used in one piece,

and where the best of timber is necessary, only the heart should be used.

The piles that we have just described—that is, those for the support of a superimposed load—are what are called bearing piles, while sheet-piles, as we have said, are for the holding up of banks of earth, during excavation or permanently. Piles are also driven in some cases in order to consolidate ground which otherwise is too loose and unstable to bear a weight. In this case, the piles are usually short, and driven very closely together, beginning with the outside circle and driving toward the center. This method, however, has gone very much into disuse of late years, owing to the fact that most engineers prefer to use concrete in such ground rather than to consolidate it by means of piles.

Fender piles are simply what their name would indicate—that is, piles driven in front of large masonry walls or other important works, in order to protect them from sudden blows.

At different times piles with screw points have been tried, the screw points having been made of cast iron and about 2 ft. in length. They never have been particularly successful, are very expensive, and should never be used except where the material through which the pile is driven consists of sand, or where timber is so expensive that there is an actual gain by the use of cast-iron points.

CHAPTER XVI.

RAMS AND HAMMERS.

The ordinary method of driving piles is by dropping a weight, either a ram, a hammer, or a monkey, upon them. This weight in some cases is made of timber loaded with iron, but usually of cast iron. It is raised either by means of hand-power or steam, usually by steam. The exact effect of these blows upon the top of the pile is not known. The effect from experiment is very irregular. The actual force with which the hammer strikes the pile can be easily calculated from the formula for accelerated velocity and the law of falling bodies. The body will fall through a space, S, in the time $\frac{\sqrt{S}}{g}$ where g equals $16\frac{1}{12}$ ft., or the space that a body falls in one second. The acquired velocity is directly proportional to the time of the fall, and the velocity at the end of the first second is $32\frac{1}{6}$ ft. Hence, falling through any space the velocity that will be acquired by a body will be $32\frac{1}{6}\ \frac{\sqrt{S}}{g}$. From this we have the velocity that the ram or hammer will have after having fallen any required distance. Then, to find the force with which that hammer will act upon the head of the pile, we have simply to multiply the weight of the hammer by this acquired velocity, and we have the number of pounds with which the hammer acts upon the head of the pile. We must remember that the velocity to be used in this case is not the velocity that the hammer had in the second before it reached the pile, but the velocity that it would have had in the next second if it had not been stopped by the pile.

From the above equation the accompanying table No. I. has been calculated, showing exactly the force of impact of a hammer weighing one ton falling through different distances.

In regard to the weight of the ram that should be used, opinions differ among engineers. A heavy ram or hammer with a very short blow is undoubtedly the best for many reasons; the only drawback to it is the increased amount of power necessary for raising the hammer. A light hammer with a long fall is very apt to split the pile, and by an examination of this table it can readily be seen that the effect of a blow does not in any way increase directly as the fall increases. Thus, a hammer falling 6 ft. gives a force of 20 tons, while a hammer falling 12 ft. only gives a force of impact of 28 tons. Thus, while we have doubled the distance through which we must move the hammer, we have only increased the working force from 20 to 28 tons.

The height of fall is also a question upon which there is great variation of opinion, but there is one thing that we must remember—that these rams or hammers in falling are not allowed to fall freely—that is, they are held in the leads of the pile-driver, and of course there is a certain amount of friction between the sides of the hammer and these leads; this friction is so great that there is absolutely nothing gained by making the leads over 40 ft.

TABLE I.

Fall of ram in feet.	Time of descent in seconds.	Force in tons for a ram weighing one ton.	Fall of ram in feet.	Time of descent in seconds.	Force in tons for a ram weighing one ton.	Fall of ram in feet.	Time of descent in seconds.	Force in tons for a ram weighing one ton.
1	0.25	8.0	15	0.96	31.0	28	1.32	42.4
2	0.35	11.3	16	1.00	32.1	29	1.34	43.2
3	0.43	13.9	17	1.03	33.1	30	1.37	43.9
4	0.50	16.0	18	1.05	34.0	31	1.39	44.6
5	0.56	17.6	19	1.09	35.0	32	1.41	45 4
6	0.61	19.6	20	1.11	35.9	33	1.43	46.1
7	0.66	21.2	21	1.14	36.7	34	1.45	46.8
8	0.70	22.7	22	1.17	37.6	35	1.48	47.4
9	0.75	24.1	23	1.20	38.5	36	1.50	48.1
10	0.79	25.3	24	1.22	39.3	37	1.52	48.8
11	0.83	26.6	25	1.25	40.1	38	1.54	49.4
12	0.86	27.8	26	1.27	40.9	39	1.56	50.1
13	0.90	28.9	27	1.29	41.7	40	1.58	50.7
14	0.93	30.0						

The weight of the hammer should be proportional to the cross-section of the pile that is to be driven. Take a pile 10 or 14 in. in diameter, and the hammer should be from 1,000 to 1,700 lbs. in weight. The following equation will give approximately the weight of hammer for the most economical driving of the pile under the following circumstances:

F = fall in feet.
W = weight of the ram.
B = breadth of the pile in inches.
T = thickness of the pile in inches.
L = length of the pile in feet.
W_1 = weight of the pile in pounds.

We then have the following equation:

$$W = W_1\left(\frac{F \times W_1}{5\,B\,T\,L} - 1\right).$$

When the pile is square, the term $B\,T$ can be replaced by S^2.

The weight of the hammer and the distance through which it falls are not the only points to be considered in connection with the driving of piles. The rapidity with which the blows can be given is a very important point and must be considered. For instance, in material like sand or silt, at every blow of the hammer the pile is driven a certain distance, the material through which it is driven is disturbed to a certain extent, and if the blows are repeated with sufficient rapidity not to allow time between the blows for the material to settle back into place, there is comparatively very little friction between the sides of the pile and the material. The pile can be driven to a very great depth with little injury to itself, and the material settles back, afterward rendering it very firm; but if the interval between the blows is of such a length that the material has time to settle back into place after each blow that has been given, then, especially in sand mixed with water, it becomes almost as impossible to force the pile down as if it had been driven through solid rock. From this can be seen the great advantage of rapidity in the blows. This is what forms one of the greatest advantages in the use of the different steam-hammers, or steam pile-drivers, so called, that have recently come into such general use. A description of these pile-drivers will be taken up later.

In salt water, or where timber would be subjected to an attack of the *teredo*, cast-iron piles have been used with great success. There were strong objections made to their use in the first place, owing to the fact that it was

supposed that they would be corroded in a short time and thus rendered useless. Of course, years enough have not yet gone by to prove by the test of time that cast-iron piles will stand the corroding action of salt water, but according to the experiments that have been made, there is every probability to suppose that cast-iron piles will under ordinary circumstances last hundreds of years. It has been found that if they can be driven in such a way that the outside skin or casing of the casting is not broken, the action of the water is very much less than if this skin is fractured and the water allowed to get upon the interior part.

In regard to the supporting power of piles, this is a question which, if certain premises are allowed, can be thoroughly treated from a theoretical standpoint, and most accurate mathematical results arrived at. The only trouble is that no two piles have the same surrounding circumstances, or can be treated in exactly the same way, so that all the formulas that are given for the supporting power of the piles have to be used with caution, and in very many cases their results will not be borne out by actual experiment.

In regard to the following formulas, they must all be used with caution, owing to the fact that there is great variation in the material through which the pile is driven. The following formula is by Weisbach :

$$L = W\left(\frac{W}{W + W_1}\right) \times \frac{H}{D}.$$

In it W is the weight of the ram in tons, W_1 the weight of the pile in tons, H the height of the fall of the ram in feet, D the depth which the last stroke drives the pile.

The following formula is taken from Rankine, and shows the relation between the blow required to drive the pile to a given depth, and the greatest load that it will bear without sinking further, supposing it to be supported by a uniformly distributed friction against its sides. Let W be the weight of the ram, H the height from which it falls, D the depth through which the pile is driven by the last blow, P the greatest load it will bear without sinking further, S the sectional area of the pile, L its length, E its modulus of elasticity ; then the energy of the blow is thus employed :

$$W \times H \frac{P^2 \times L}{4PS}.$$

This is the portion employed in compressing the pile, and $P \times D$ multiplied in driving it.

From which P equals

$$\sqrt{\left(\frac{4ESWH}{L} + \frac{4E^2S^2D^2}{L^2}\right)} - \frac{2ESD}{L}.$$

The piles are generally driven until P by this formula equals 2,000 or 3,000 lbs. to the square inch of sectional area, and as their working load is from 200 to 300 lbs., that gives a factor of safety of about 10.

It is very important that all the piles which are to bear a distributed load should be driven uniformly, so as to insure that each pile is supporting its proper share of this load, and it is necessary to have some data to adhere to in driving them.

The following very simple formula by Sanders probably gives as good results as any, where $W = \frac{R}{8} - \frac{F}{D}$ where W is the weight that can be safely placed on the pile, R the weight of the ram, F the fall of the ram in making the last blow, and D the distance the pile sinks with the blow.

Comparing these formulas, we find that Rankine and Weisbach give the supporting power of the pile about $5\frac{1}{4}$ times as much as Sanders, but as each of these authorities state that the safe working load should be from $\frac{1}{10}$ to $\frac{1}{8}$ of the amount given by their formulas, the result will come very near to that given by Sanders.

The accompanying table, No. II., gives the supporting power of piles, calculated by the aid of the various formulas :

The letters have the following signification :

$W =$ the safe load on the pile in Sanders's formula and the theoretical load in Rankine's and Weisbach's.

$F =$ the fall of the ram in making the last blow.

$D =$ the distance the pile sinks with the last blow.

$R =$ the weight of the ram, which is taken constant and equal to one ton.

$L =$ the total length of the pile.

$P =$ the weight of the pile.

$S =$ the sectional area of the pile, which is taken at 0.7 of a foot.

$E =$ the modulus of elasticity, with a value of 331,100 inch-pounds.

TABLE II.

No. of Pile.	Depth in Ground.	Total length of Pile (L).	Value of $P = L \times 0.22$.	Value of D.	Value of F.	Sanders's.	Rankine's.	Weisbach's.
	Feet.	Feet.	Tons.	Feet.	Feet.	Value	(W) in	tons.
1	15.00	20.00	0.440	0.0573	10.58	23.09	111.68	128.22
2	13.00	18.00	0.396	0.1094	11.83	13.52	87.03	77.75
3	12.00	17.00	0.374	0.0833	10.00	15.00	91.41	87.72
4	12.50	17.50	0.385	0.0833	10.50	15.75	94.52	91.34
5	13.25	24.75	0.544	0.0313	10.00	40.00	122.04	206.93
6	13.00	24.75	0.544	0.0677	11.50	21.23	103.79	109.53
7	13.67	25.17	0.544	0.0885	10.00	14.12	81.37	72.71
8	16.00	27.50	0.605	0.0573	10.00	21.82	97.69	109.31
9	15.58	26.33	0.579	0.0625	10.00	20.00	95.52	101.33
10	16.00	27.00	0.594	0.0625	10.00	20.00	94.82	100.38
11	16.75	27.50	0.605	0.0625	10.00	20.00	94.33	99.69
12	17.50	28.25	0.622	0.0469	10.00	26.67	103.97	131.45
13	14.67	24.17	0.532	0.0729	10.00	17.14	91.05	89.42
14	13.50	23.50	0.517	0.0833	10.00	15.00	85.47	79.14
15	17.67	26.17	0.576	0.0678	10.00	18.46	92.31	93.71
16	17.25	25.75	0.567	0.0573	8.00	17.45	85.06	89.11
17	18.25	23.73	0.522	0.0781	10.00	16.00	88.28	84.09
18	18.67	24.17	0.532	0.0833	10.00	15.00	84.93	78.33
19	14.92	20.42	0.449	0.0833	10.00	15.00	88.16	82.82
20	16.25	21.75	0.479	0.0729	10.00	17.14	93.45	92.72

Where piles are to be driven any distance, and through material that presents any particular resistance, the head of the piles should always be banded by means of a heavy wrought iron ring, this ring being made of about $\frac{5}{8}$-in. iron 3 in. broad. If, during the process of driving, the head becomes bruised so as to form a sort of a cushion, this bruised portion of the pile should be instantly sawed away and the head rebanded, as as much as four-fifths of the effective force of the ram soon becomes absorbed in this semi-elastic cushion.

In regard to shoeing piles, unless the material presents a great deal of resistance, it is not absolutely necessary to shoe them. They should be pointed to a certain extent, and, when necessary, shod by means of wrought-iron or cast-iron shoes. The simpler the form of the shoe, of course, the less expensive the work. Any treatise on pile-driving shows the different forms of shoeing that are used.

In driving piles in deep water, or under circumstances where it is necessary for the pile-driver to be placed a great distance above where the ultimate top of the pile is to come, in order to save timber the piles are only cut the required length, and when the top comes below the bottom of the leads, a dolly or follower is used to drive them farther. This is simply a piece of timber approximately the same size as the pile, and set upon the top of it. Under some circumstances an iron dowel is used, or a very broad band encircling both the top of the pile and the bottom of the follower. There are many objections to using a follower, and it should only be used when, from an economical standpoint or other circumstances, it is impossible to use timber of sufficient length to dispense with it. In using a follower, from half to three-fourths of the force of the blow is often absorbed in the follower itself, and is no way effective in driving the pile. This constitutes one of the greatest disadvantages connected with the follower. Another disadvantage is the great difficulty in driving the pile true, as far as its direction goes.

(TO BE CONTINUED.)

CATECHISM OF THE LOCOMOTIVE.

(Revised and enlarged.)

BY M. N. FORNEY.

(Continued from page 431.)

CHAPTER XXXV.

ACCIDENTS AND INJURIES TO PERSONS.

QUESTION 866. *In case an accident occurs and one or more persons are seriously injured, what can be done by those present?*

Answer. In such cases it very often happens that with knowledge, and sufficient coolness to apply that knowledge, one or more non-medical persons who are present when an accident occurs can do as much or more toward saving life and allaying pain *before* a doctor comes than he can *afterward.* The following cases cited by Dr. Howe in his book on "Emergencies" will illustrate this:

"*Case* 1.—A machinist was admitted to a New York hospital suffering from wounds of the wrist and palm of the hand. On arriving at the hospital the entire clothing on one side of his body was saturated with blood, from the loss of which he was partly insensible. On making an examination, it was found by the surgeon that a folded handkerchief was bandaged over the center of the wrist, and that the wound in the palm of the hand was untouched. The pad was placed on the wrist, as if the greatest care had been exercised to avoid pressing on either of the two arteries. The bleeding in this case could easily have been controlled if the bandage and pad had been properly applied. The patient, however, developed erysipelas, and not having sufficient vitality to carry him through, died the fifth day."

"*Case* 2.—A laborer fell from the front platform of a car at Harlem, and had his right foot crushed by one of the wheels. An ordinary bandage was placed on the limb, without any compress over the vessels. In bringing the man to the hospital, the rough jolting of the carriage set the wound bleeding, and by the time he reached his destination he was apparently lifeless. The vessels were tied and stimulants administered, but he never rallied. Death occurred six hours after his admission. His injuries, independent of the bleeding, might indeed have terminated his life; still the chances would have been in his favor if a compress had been applied to the limb to prevent bleeding. The fact that such a thing was not done shows either culpable negligence or deplorable ignorance."

Many similar cases constantly occur where a little intelligent, timely action of those present would save the life of an injured person, who without such help must die before professional surgical aid can be obtained.

QUESTION 867. *When it is found that one or more persons are seriously injured, what is the first thing to be done?*

Answer. The first thing to do is to extricate the person or persons from the danger, and at the same time send a messenger for a doctor. If it is doubtful if one can be obtained by sending in one direction, send two or more messengers in different directions.

QUESTION 868. *To what kind of injuries are locomotive runners and other persons employed or traveling on railroads exposed?*

Answer. They are liable to be bruised or crushed in case of collision or running off the track, or of injury from falling off the train, or of being run over by a moving train. Brakemen and others whose duty it is to couple cars are liable to have their hands, arms, or bodies crushed between the cars, and locomotive engineers are sometimes burned or scalded if an accident happens to their engines. Train-men are also frequently exposed to very great cold in winter and heat in summer, and are thus liable to be frost-bitten or sun-struck. Passengers are seldom injured excepting through their own carelessness, unless in cases of collision or running off the track and the destruction of the cars. Strangers and railroad employés are frequently run over by trains while walking or being on railroad tracks. It is estimated that from five to six thousand people are killed and wounded every year from "being on" railroad tracks. Frequent accidents occur to deaf people in this way, and it is not very unusual to hear of train-men who sit on the main track at night while their trains are waiting on the side-track for another train to pass, go to sleep while in that position, and then are run over by the passing train.

QUESTION 869. *How can accidents from being on the track be avoided?*

Answer. The obvious way is to stay off of railroad tracks, unless called there by duty, then to stay there as short a time as possible, and while there exercise the utmost vigilance to keep out of the way of moving engines and cars. It should be remembered that there is comparatively little danger to persons on engines or cars, but a railroad track is almost as dangerous as a battlefield to those on foot or who are traveling in wagons or carriages. It should be a universal rule with every person, whether a railroad employè or not, *always to come to a full stop before crossing or going on a railroad track.* If this rule was universally adopted many lives would be saved and much suffering avoided.

QUESTION 870. *When persons are crushed or dangerously wounded, what are the chief immediate sources of danger and death when their wounds are not necessarily fatal?*

Answer. First, excessive bleeding in case an artery is ruptured; second, the shock to the whole system, from which the sufferer may not have the strength to recover.

QUESTION 871. *When does bleeding from a wound become dangerous?*

Answer. Profuse bleeding is always dangerous, but it should be remembered that bleeding occurs from two sources: first from the arteries, which are the vessels which convey the blood *from* the heart, and second from the veins, through which the blood flows back to the heart. The first is called *arterial* bleeding and the second *venous* bleeding. Now it must be remembered that the heart is the great force-pump of the body, and that it supplies all parts of the body with blood, somewhat as the feed-pump of a locomotive supplies the boiler with water. The arteries referred to fulfil the same purpose that the feed-pipe does to a locomotive pump—they convey the fluid from the pump to the place where it is needed. Now the blood is forced into these arteries with a certain amount of pressure, so that if any of them are cut or injured the blood will flow out in a jet or spurt just as the water will escape from a feed-pipe if that is ruptured. The blood which flows through the veins back to the heart may, on the other hand, be compared to the water in the supply-pipes of a locomotive pump—that is, there is very little pressure on it, and therefore if they are injured the flow of blood from them is less rapid than from the arteries. It will therefore be seen that arterial bleeding is much more dangerous, because the blood flows from them under a pressure.

QUESTION 872. *How can arterial bleeding be distinguished from venous bleeding?*

Answer. The blood is of a bright scarlet color, and is forced out in successive jets; each jet corresponds with the movements of the heart. This characteristic spurting is caused by the intermittent force-pump action of the heart, driving out the blood. Venous bleeding is distinguished from arterial by the dark blue color of the blood when flowing from the wound. It never flows in repeated jets, but oozes slowly from the wounded surfaces. Venous blood is traveling toward the heart, and there is consequently little force behind to cause a more rapid flow. This form of bleeding is comparatively harmless, unless occurring from very large veins.*

QUESTION 873. *How can the bleeding be stopped in case an artery is cut or ruptured?*

Answer. The most efficient and available method is the application of PRESSURE on the artery BETWEEN THE WOUND AND THE HEART. Under ordinary circumstances this can be most effectively done by simply passing a handkerchief around the limb above the wound, or between it and the heart; the ends of the handkerchief are then tied together. A pad is then made, either of cloth rolled up, cotton waste, a piece of wood, or a round stone about the size of a horse-chestnut well wrapped, or any substance from which a firm pad can be quickly made, which is placed over the artery. The handkerchief, folded in the form of a bandage, is placed over the pad and passed around the limb and tied on the opposite side to the pad, and then a rounded stick about six inches long and three fourths of an inch in thickness is passed under the knot, so that the handkerchief may be twisted sufficiently tight to stop the bleeding by pressing the pad upon the artery; the twisting of the stick and the pressure upon the artery should only be sufficient to stop the bleeding from the artery; too much pressure or twisting would be painful and might produce other serious consequences. While the bandage is being prepared, some one should compress the artery with his fingers or thumb, so as to prevent as much loss of blood as possible.

QUESTION 874. *What is the position of the arteries in the body and how can their location be known?*

Answer. The position of the principal arteries is shown in fig. 439. They proceed from the heart *h*, with branches, *a a* and *b b*, which extend along each limb. These branches subdivide again below the knees and elbows, and again in the hands and feet. The position of the arteries can be felt by their pulsation at almost any part of them, but at some places they are covered so thickly by the muscles, that it is more difficult to feel their throb than it is where they are near the

* "Emergencies and How to Treat Them," by Joseph W. Howe, M.D.

surface. At *a* and *a* they are near the surface of the body, and also in the thighs at *b b*, and again at *c c*, immediately back of the knees, and in the wrists at *d d*. At these places the pulsations of the blood can be distinctly felt.

QUESTION 875. *In case of a wound and rupture of the arteries in the arm, what should be done?*

Answer. The artery should be firmly compressed at *a* with the thumb until a bandage and pad can be prepared. The pad should then be applied over the artery and compressed as explained in answer to Question 873. The bleeding can also be stopped by placing a round piece of wood or other form of

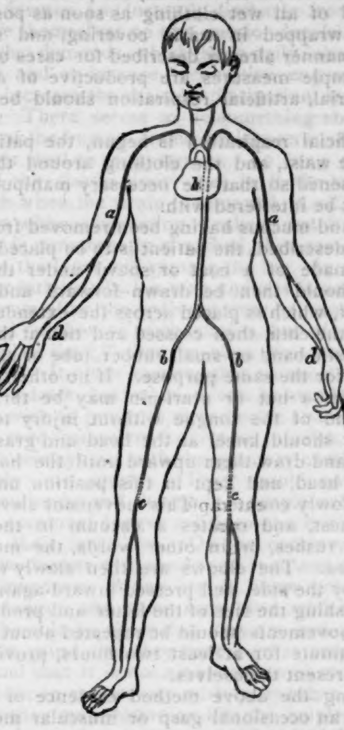


Fig. 439.

pad between the arm at *a* and the body and then tying the arm tightly against the body, so that the pad will be pressed against the arm.

QUESTION 876. *In case of rupture to an artery below the knee, where should the pressure be applied?*

Answer. The artery approaches near the surface at *c c*, immediately back of the knee, where it is represented in dotted lines in fig. 439. Pressure should therefore be applied at that point first with the thumb until a bandage can be applied. The bleeding can also be stopped by elevating the leg and allowing it to rest on the back of a chair or other similar support. The weight of the leg will then bring sufficient pressure on the artery to stop the bleeding. A towel or other soft material should be placed over the back of the chair, so that the pressure will not be too painful to the sufferer.

QUESTION 877. *If an artery is ruptured in the thigh above the knee, where should the pressure be applied?*

Answer. In the thigh at *b*, where the beating or pulsations in the artery can be distinctly felt. The reader should familiarize himself with the position of the arteries by feeling their location in his own body. By doing so he may be able to save his own life, the life of a companion or other person in case of accident, whereas without such knowledge the injured person might die.

QUESTION 878. *After the arterial bleeding has been stopped, if blood should continue to ooze out of the wound, what should be done?*

Answer. The wound should be filled with lint or clean cotton waste; and the limb then be bandaged by beginning at its extremity and wrapping the bandage closely and evenly around it, so as to bring, as nearly as possible, an equal pressure on the whole of it. Bandaging the limb in this way up to the point where the pressure is applied to the artery, will prevent swelling, and the veins will be compressed so that the blood will not flow from their torn extremities.

QUESTION 879. *When the bleeding has been stopped, what should be done?*

Answer. The injured person should be laid in as comfortable a place as can be procured for him, and should be given a moderate drink of water. If much exhausted, two or three tablespoonsful of brandy or whisky, mixed with an equal quantity of water, should be given first, and smaller quantities, *of not* MORE THAN A TABLESPOONFUL at a time, should then be given every half hour. Usually wounded persons are given too much stimulant, so that frequently they are injured more than they are benefited thereby.

After a person has lost much blood, he feels an intolerable thirst, but if too much water is given him, he is apt to become sick and vomit, which weakens him still more. It is therefore best to give him very little water, say a teaspoonful at a time, after the first drink, or if ice can be obtained, give the sufferer pieces of ice frequently, which can be allowed to melt, in his mouth.

QUESTION 880. *In case any bones are broken, what should be done?*

Answer. The limb should be supported as comfortably as possible until a doctor's services can be obtained. There is danger with a broken limb that the bones will protrude through the flesh and skin, to avoid which the limb should be placed in a natural position and laid on a pillow, car cushion, or other soft object. This should then be wrapped around the limb and tied in this position, so as to prevent any movement of the broken bones. A temporary splint may be made by tying an umbrella or light strips of wood to the broken limb.

QUESTION 881. *When a person is insensible, what should be done for him?*

Answer. Lay him down in as comfortable a place as the circumstances will permit, and protect him from cold, rain, or hot sun, as may be needed. A common error is to place injured and insensible persons in an erect position or in a chair. If he is insensible he should *always* be laid down with his head slightly lower than his body. Then water should be dashed two or three times on his face, and warm bricks, stones, or pieces of iron, such as coupling links or pins, applied to his feet, and in the arm-pits and between the thighs, being careful that the warm objects applied are not hot enough to burn. Then cover the person with blankets, heavy coats, or anything else which will keep him warm. Wounded persons soon become cold and chilled, the effects of which are very injurious, and therefore especial pains should be taken to keep them warm. In very cold weather there is great danger that injured persons will be frost-bitten, which must be carefully guarded against.

QUESTION 882. *What is meant by "shock" or "collapse"?*

Answer. Shock is a condition in which there is more or less diminished energy of the heart and circulation, and is the result of a severe impression made upon the nervous system, produced by either a physical injury or a mental emotion. The majority of cases met with are the result of extensive burns or other grave injuries, particularly those produced by gunshot wounds and railway accidents, which are generally associated with great laceration and crushing of the tissues, and mental excitement. Severe cases of shock may be produced by fright alone. Shock may be of a very mild character, as the result of a trifling injury or fright, the symptoms being hardly noticeable, of short duration, and demanding no treatment; or, it may assume a form which is rapidly fatal.*

QUESTION 883. *What are the symptoms of "shock"?*

Answer. In some cases, when the injury is slight, the symptoms may be hardly apparent, or, only a pale face and a weak and rapid pulse, a slight nausea, and a general sense of prostration may be produced. In cases of severe injury, such as might be caused by a serious railroad accident, the person injured is conscious, but dazed and flighty, cannot realize his condition, and apparently only appreciates loud and repeated questions; articulation is difficult, although there is no paralysis present. The sensibility to pain may be so blunted that an operation can be performed without the patient knowing it. The extreme pallor and coldness of the skin are startling; the surface of the body is covered with moisture; large beads of sweat cover the forehead; the pulse at the wrist may be lost, or, if perceptible, is weak, rapid, and irregular; the features are shrivelled, particularly about the nose, which appears pinched; the eyes are lusterless, sunken deeply in the sockets, and turned upward, the pupils being generally dilated. There is no other condition which so closely resembles death. The symptoms may continue for a few minutes or a number of hours, and often end in death.

QUESTION 884. *What should be done for a person in the condition described?*

Answer. Those in attendance should at once loosen the clothing, or cut it open rather than have too much delay, and make a rapid examination to ascertain whether severe bleeding exists,

* From a Manual of Instruction in the Principles of "Prompt Aid to the Injured," by Alvah H. Doty, M.D., published by D. Appleton & Co., New York.

or if one or more of the bones in the legs or arms are broken. If there is bleeding it should be stopped as already directed, or if any of the bones are broken a temporary splint should be applied as quickly as possible. The patient should then be carried to the most convenient and sheltered place within reach. While being removed the head should be as low as or some what lower than the body, or the extremities may be slightly elevated, so as to favor the flow of blood toward the brain. If possible, four persons should assist to carry the patient, one for each extremity and the contiguous portions of the body. His clothing should be removed and he should be made as comfortable as possible, and kept warm by proper covering and applying bottles of hot water, warm coupling-pins, links, or other pieces of iron, or bricks, or stones. These should be placed about the arms and legs, inside the thighs, and under the armpits and about the body, but not about the head, as this might favor congestion when reaction occurs. If heat cannot be applied as described, the injured person should be rubbed in order to excite circulation. If able to swallow, he should be given about two teaspoonfuls of whisky or brandy, with a small amount of hot water, or, still better, hot milk; this may be repeated every ten or fifteen minutes, until four or five doses have been taken, or reaction becomes apparent. When the latter occurs, the stimulant should be diminished or discontinued. When reaction occurs, the color and warmth gradually return to the skin, the eyes are brighter, and the symptoms indicate an approach to the normal condition. Vomiting is regarded as a favorable symptom and generally denotes reaction. This does not always insure safety, and the sufferer should be carefully watched. When reaction has taken place warm beef-tea, broth, or milk should be given in small quantities.*

All assistance and attention should be given to a wounded person with the least noise and excitement, and all crowds and idle spectators should be driven away and every effort made to keep the sufferer comfortable and quiet.

QUESTION 885. *If a person is crushed or severely burned, what should be done?*

Answer. The immediate danger from such injuries arises from the "shock" to the system. It is usually best to bandage the part which is crushed until surgical aid can be obtained, and the sufferer treated as explained in answer to Question 884.

QUESTION 886. *What should be done for a person who has been burned or scalded?*

Answer. The wound should be dusted with bicarbonate of soda (common baking soda, *not washing soda*), wheat flour, starch, chalk, or charcoal, and then dressed with lint or clean cotton waste and loosely bandaged. Vaseline, cosmoline, olive or linseed oil, or molasses may be employed for dressing burns or scalds. If blisters are produced the clothing should never be forcibly removed from them, but carefully cut off with scissors as close to the burn as possible. The small pieces adhering to the skin may be afterwards washed away with warm water, or softened with oil and detached later. If the blisters are large, they should be pricked at their lowest part and the contents allowed to escape. The oily substances already recommended should then be applied as described.*

If the injury should be severe, a shivering, followed by depression, is very likely to come on. To check this, warmth in the form of hot applications and stimulants should be used, as already explained.

QUESTION 887. *What should be done for a frost-bite?*

Answer. Warmth should be applied to the frozen part very gradually by rubbing with snow or pouring cold water on it. The occurrence of stinging pain, with a change in color, is a signal to stop all rubbing or other measure which might excite inflammation. If the frozen part turns black the next day, a poultice should be applied.

If persons exposed to the cold become very much exhausted or sleepy, stimulants should be given, as explained in answer to Question 884, and the body briskly rubbed with the hands and warm flannel or other woolen material.

QUESTION 888. *How should a person be treated who has been sun-struck?*

Answer. Apply cold water or ice to the head, place the sufferer in a cool place, and make him comfortable. After being sun-struck the person should not work for some days or weeks thereafter, until his health and strength are fully recovered.

QUESTION 889. *How should persons who have been under water for a short time, and unconscious when taken out, be treated?*

Answer. Persons who have been under water for four or five minutes or more are not usually restored to life, although numerous cases are recorded where resuscitation was effected after an interval of twenty minutes. If they have been under water but a few moments, the water, mud, and mucus should be removed from the mouth and nose and the tongue should be pulled forward and the person should be turned on his side, face downward, to allow the water to escape. He should then again be turned on his back, while the hands of the attendant are placed on the belly and pressure directed upward and inward toward the diaphragm. This movement tends to stimulate respiration, and should be repeated two or three times at intervals of two or three seconds. The mouth in the mean time should be kept open by a cork or piece of wood, or a knot tied in a handkerchief, etc., in order that the passage of air to the lungs should not be interfered with. Tickling the nose with a feather or straw also stimulates breathing. When breathing commences and consciousness returns, the patient should be carefully divested of all wet clothing as soon as possible, be well rubbed, and wrapped in warm covering, and stimulants be given in the manner already described for cases of "shock."

If these simple measures are productive of no good result after a short trial, artificial respiration should be at once resorted to.

Before artificial respiration is begun, the patient should be stripped to the waist, and the clothing around the latter part should be loosened so that the necessary manipulations of the chest may not be interfered with.

The water and mucous having been removed from the mouth and throat as described, the patient is to be placed on his back, with a roll made of a coat or shawl under the shoulders; the tongue should then be drawn forward and retained by a handkerchief, which is placed across the extended organ and carried under the chin, then crossed and tied at the back of the neck. An elastic band or small rubber tube or suspender may be substituted for the same purpose. If no other means can be made available, a hat or scarf-pin may be thrust vertically through the end of the tongue without injury to this organ. The attendant should kneel at the head and grasp the elbows of the patient and draw them upward until the hands are carried above the head, and kept in this position until one, two, three can be slowly counted. This movement elevates the ribs, expands the chest, and creates a vacuum in the lungs into which the air rushes, or, in other words, the movement produces *inspiration*. The elbows are then slowly carried downward, placed by the side, and pressed inward against the chest, thereby diminishing the size of the latter and producing *expiration*. These movements should be repeated about fifteen times during each minute for at least two hours, provided no signs of animation present themselves.

If after using the above method evidence of recovery appears, such as an occasional gasp or muscular movement, the efforts to produce artificial respiration must not be discontinued, but kept up until respiration is fully established. All wet clothing should be removed, the patient rubbed dry, and if possible placed in bed, where warmth and stimulants can be properly administered.*

CHAPTER XXXVI.

RESPONSIBILITY AND QUALIFICATIONS OF LOCOMOTIVE ENGINEERS.†

QUESTION 890. *What are the dangers to which the engineer and the fireman are exposed by their work on the engine?*

Answer. Engineers and firemen are not only exposed to great bodily injury or even death by every accident which may happen to their engine, but unless they are very careful to preserve their health it is quickly destroyed by the constant changes of the weather to which their position exposes them, and also by the effect of the heat of the fire and by the smoke by which they are often surrounded.

In order to protect themselves in a measure from the injurious effects of change of weather, smoke, cold, etc., frequent bathing and cleansing of the skin are absolutely necessary, and also the wearing of a woolen undershirt next the skin at all seasons.

The gases of coal which pour out of the furnace-door, if it is opened when the throttle is closed, have an especially injurious effect on the throat, lungs, etc. They should see to it, therefore, that the blower is always started before the fire-door is opened, in order that these injurious gases, which have collected during a halt, may be drawn forward and up the chimney by the draft.

The steady, loud clatter which the engine makes while running has an injurious influence on the nervous system. The engineer should therefore endeavor to lessen these shocks of the engine as far as possible by keeping watch over it and keeping its parts accurately adjusted. In order to keep himself fresh and strong in his service, which is extremely exhaustive

* From "Prompt Aid to the Injured," by Alvah H. Doty, M.D.

* From "Prompt Aid to the Injured," by Alvah H. Doty, M.D.

† A considerable part of this chapter is a translation from Professor George Kosak's "Katechismus der Einrichtung und Betriebes der Locomotive."

to body and mind, the engineer should try to strengthen himself by regular, temperate living, and eating abundant nourishing food. The common use of strong drinks, which undermines the mental and physical strength of men, should be avoided by a person occupying the exhaustive and responsible position of a locomotive engineer. If in ordinary life a drunken man is unfit for any simple work, how shall a drunken engineer or fireman undertake the difficult management of so great, so delicate, and so costly a machine as a locomotive? How can hundreds of men quietly trust their lives and limbs to such a man, whom no one can help despising? Rightfully, therefore, conscientious railroad managers place the greatest stress on the *sobriety* of the engineers and firemen, and instantly discharge from their service those who give themselves up to a passion for drink.

Owing to the demands which their daily labor makes upon their strength and endurance, locomotive engineers should be careful not to increase the drain by dissipation, irregular hours, or overwork. There seems to be something about the power of endurance of the human frame analogous to the capacity of a bar of iron or steel to resist strains. So long as the strains do not exceed the elastic limit—that is, if the bar recovers its original length when the strain is removed, it will bear millions of such strains without becoming weaker; but if it is strained so hard that it is permanently stretched, then comparatively few applications of the force will rupture the bar. In a similar way, if the strain or fatigue which a man endures is no more than he will recover from after the ordinary rest, he can endure an almost unlimited number of such strains, but if the fatigue exceeds his "elastic limit," then he soon becomes permanently injured thereby. It often happens that an excessive amount of work is unavoidable, but when it can be avoided it should be by those who wish to preserve their health and strength.

In order to save themselves from great injuries, engineers and firemen should always act with the greatest caution, and never rush carelessly into danger. They should never adopt the principle of foolhardy and thoughtless people, who by the consciousness of continual danger fall into the habit of carelessly "trusting to their luck," etc. On the contrary, they should always face the danger with their eyes open and with the greatest conscientiousness. Many try to show great courage by scorning the danger, and some such even wish to meet a little in order to be able to show that they are not afraid. These should bear in mind that they have a great responsibility laid upon them, and that it is not alone their own well-being or life which is at stake in case of any mishap, but that by their careless behavior they may wound or kill the helpless people who are committed to their care, cause incalculable misery by robbing families of their sole support and of their children; and bring great sorrow and mourning to their fellow-men. The thought of the curse and the despair of the survivors may give sleepless hours even to a locomotive engineer who knows himself to have been without any fault regarding an accident; how much more must it be with him who cannot give himself this assurance? There are not wanting instances in which the engineer who caused such an accident by his thoughtlessness, driven to despair by his own heavily-burdened conscience, went miserably to ruin.

QUESTION 891. *What should a locomotive engineer and fireman do to preserve their health?*

Answer. The following excellent suggestions* to workingmen for the *prevention* of sickness may be followed by all locomotive engineers and firemen, to their own great advantage and that of their families.

They include, first, attention to home surroundings, and second, to personal habits.

In regard to the first, one of the earliest physicians, Hippocrates, said that the essentials of health were pure air, pure water, and a pure soil. Your home should, above all things, be free from damp. It should not be built upon made land or where it can be flooded by rains or by a rise of tide. Dampness is a certain source of consumption, rheumatism, croup, diphtheria, and other diseases. The nearer your living-rooms are to the ground, the more danger there is of damp. It is better to occupy an attic where you can get the sun and the air than a basement.

Again, new houses are liable to be damp from the evaporation from the plaster and mortar, which contain a large amount of water. A Spanish proverb says of new houses, "The first year for your enemies, the second year for your friends, and the third you may live there yourself." Again, cellar air is unwholesome; and this is another reason why basement rooms are bad. It is very unwise to store vegetables in cellars, or anything that will cause impurity of the air.

Pure air is the most vital thing of all. One may live without proper food and drink, and on a damp soil with impunity, but foul air slays like a sword. Every person needs pure air to breathe. Each time we empty our lungs a certain amount of impure air is thrown off. Thousands die yearly for lack of pure air. It is free to all; it costs nothing. Open the window, and it flows in abundance to the beggar as to the millionaire, bringing health and life to all—if only people would not shut and bar it out in their blind, stupid ignorance.

What is it that makes most people sick? Eating too much and too fast; drinking too much; want of fresh air; want of sunlight; want of exercise; want of cleanliness. Few persons die of starvation—many do of gluttony.

Bathe as often as you can.* Remember "cleanliness is next to godliness," and a foul body means a foul mind. Keeping the pores of the skin open is a prime element of health. How carefully we groom our horses! and is not a man's health as precious as that of a horse?

Let your wife and children have as much out-door exercise as they can get. It will be a change, and won't do the least harm.

Don't sit in damp clothes if you come home wet. If you feel chilled and cold, soak your feet in a pail of hot water, then go to bed and pile on the clothes till you sweat, and you will escape catching cold. In such cases, hot tea, or coffee, or soup is better than whisky to warm you. In cold countries tea is preferred to any drink. Liquor should never be taken by a sick person, unless by a doctor's orders.

Clothes should fit loosely, should be light, warm, and porous, should be adapted to the season as to color, should be frequently changed, and should be scrupulously clean.

In cooking, use the frying pan as little as possible; greasy food is very unwholesome. Avoid too much pork and liquors.

Eat slowly, chewing the food well, and drink very little liquid of any kind while eating. Tea is not food, and too much of it is drunk by many persons, especially women and children. Eat oatmeal and hominy in preference, and give children plenty of milk. Beans are very nutritious.

Don't shut every cranny and crack to keep out the air from the rooms, but let the windows stay open for a time.

Don't forbid the blessed sun from entering your windows. Don't stay in a house that has a bad smell in it.

Don't live in dark, gloomy, close rooms if you can get sunny, cheery ones.

Remove all garbage and refuse as soon as possible from your houses.

Have the walls and ceiling whitewashed or kalsomined once or twice every year.

In looking for apartments, always strive to secure a well-ventilated bedroom. Air the room and bed-clothing every morning. Keep as few clothes, not in use, as possible in the bedroom, and do not sleep in any garment which is worn by day.

QUESTION 892. *What requirements and duties should every locomotive engineer fulfill?*

Answer. Every locomotive engineer should fulfill the following requirements and duties:

1. He should have an exact knowledge of the engine intrusted to him, and a general knowledge of the nature and construction of steam-engines generally. Likewise, he should be perfectly familiar with the management of the boiler, the running of the engine, and the way of keeping the working parts in good condition; also, with the forms and peculiarities of the line of road on which he runs, the rules which govern the running of trains and with the signal system adopted.

2. *Health* and *bodily strength* he must have in abundant measure in his position, which is exhausting and in which he is exposed to all sorts of weather.

3. He should have at least a good, plain common-school education, and be ready at reading, writing, and arithmetic.

4. He should always carry out *exactly* and *cheerfully* the regulations of the service, or the instructions given him by special orders from the officers over him.

5. *Faithfulness, frankness, and honesty*, which characterize an upright man in ordinary life, and also the strictest *temperance* in the use of strong drink, he should possess in a high degree in his very responsible position.

6. He should have acquired a certain degree of skill in putting together and taking apart locomotives, and also in repairing separate parts of them. It is desirable that he should always be present when his own engine is taken apart, put together, or repaired, in order that he may acquire a thorough knowledge of its condition and learn to understand properly the importance of its various parts.

7. In caring for his engine, he must preserve perfect cleanli-

* Published by the Citizens' Sanitary Association of Brooklyn, N. Y.

* If a bath tub is not available, a damp or wet towel—the coarser the better—rubbed briskly all over the body every morning is an excellent substitute for a bath.

ness and order, and in using fuel he must manifest the greatest care and rigid economy.

8. Whenever there is danger, coolness and self-possession are indispensably necessary, and any thoughtlessness or recklessness is to be strictly avoided.

9. Toward his superior officers his behavior should be respectful and obliging; toward those under him, patient and kindly, and at all times he should avoid profanity and all intemperate language. He should endeavor, as far as possible, to instruct the fireman who accompanies him and make him familiar with the construction and management of the engine, and should see that he does his work strictly in accordance with his instructions.

It is the *fireman's* duty to follow the engineer's instructions strictly, and in case of any sudden disability of the engineer he must stop the engine in accordance with the instructions given him, and then give the proper signals for help, until another engineer arrives. In the meanwhile the engine is to be kept at a halt with all the usual precautions.

10. The egnineer should try to keep himself informed of the progress and improvement of locomotives by reading suitable books and technical periodicals, and when possible acquire some skill in geometrical and mechanical drawing, in order to accustom himself to accurate work and sound and systematic thinking.

QUESTION 893. *What studies should mechanics, locomotive engineers, and firemen take up, and what technical books should they read?*

Answer. As already stated, they should know how to read and write their own language, and understand arithmetic and have some knowledge of geography. Every locomotive runner and fireman has a good deal of spare time, a part of which he can devote to study, and all of them, even if they have not had the advantage of early education, could by industry and perseverance acquire a knowledge of "reading, writing, and ciphering." The assistance of a good teacher should always be procured, if possible. With so much knowledge, some book on natural philosophy can be read to advantage, and then some book on mechanics. It should always be remembered, however, that the mere buying of books contributes very little knowledge to the owner. It is the reading and *understanding* them which "increases knowledge." Before buying books it will be well to ascertain from persons capable of judging of their character, whether they are worth buying, as there is more difference in the quality and character of books than there is in almost any other commodity which is sold. Many which are written and published are not worth buying or are unsuited to the wants of the purchaser, while a really good book—and there are many such—is a treasure.

CHAPTER XXXVII.

THE CARE OF LOCOMOTIVES WHILE IN THE ENGINE HOUSE.

QUESTION 894. *How can defects, such as cracked plates or dangerous corrosion, be discovered in a locomotive boiler?*

Answer. Such defects are usually indicated by leakage while the engine is in service. They are shown by a little water or steam oozing at the point where the defect exists. When the engine is cold a slight collection of incrustation or rust on the outside of the boiler will show that there has been a leak. A defect in the fire-box will often be shown by a leak at the mud-ring. When a fire-box plate is cracked it usually opens suddenly, so that the leak shows at once. Tubes are liable to leak when there is no other defect excepting that they need calking, but when this is done the tube-plate should always be examined to see whether it is cracked.

QUESTION 895. *How can internal corrosion or grooving be discovered?*

Answer. Unless it has become so serious as to cause an external leak, this cannot be discovered excepting by an internal inspection of the boiler. To do this the dome-cover must be taken off and a person must go inside of the boiler and examine carefully every part that is accessible. To make an internal inspection thorough the tubes must be taken out. When water is of a corrosive character, or contains much solid matter which is deposited inside of the boiler, such an inspection should be made frequently, but when the water is pure it is not essential to do it often.

QUESTION 896. *How can defects in braces or stays or broken stay-bolts be discovered?*

Answer. Broken braces and stay-bolts are indicated sometimes by the bulging of the plates of the flat parts of the boiler. Broken stay-bolts may often be discovered by an expert by sounding them with a hammer, and if their ends are drilled, as explained in answer to Question 178, their fracture is shown by the leakage. An internal inspection is the only way of being sure that the braces are in good condition.

QUESTION 897. *What must be done to prevent the inside of the boiler and the tubes from becoming covered with incrustation?*

Answer. The first and most effective preventative is to get the purest water that is obtainable for use in the boilers. Having done this, if it contains much solid matter, the boiler must be blown out and washed out often. If the water forms a solid deposit it will be necessary to take out the tubes and crown-bars at intervals, and clean them and the inside of the boiler thoroughly.

QUESTION 898. *What should be observed with reference to the smoke-box?*

Answer. It should be noticed whether the front and door are securely fastened so as to be air-tight. If air leaks into the smoke-box the sparks or cinders are liable to take fire on the inside of it, which heats all the parts about it, blisters the paint outside, may cause the steam and exhaust-pipes to leak, and destroy the wire netting. It should also be observed whether the convey or exhaust-pipes, dampers, netting, etc., are in their proper position and securely fastened.

QUESTION 899. *What may happen to the convey or exhaust-pipes?*

Answer. They may get loose or may require adjusting. Moving them up or down has an important influence on the draft, but experience is the best teacher with reference to their adjustment.

QUESTION 900. *What may happen to the wire netting in the smoke-box or in the top of the chimney?*

Answer. It wears out often and gets holes in it which allow sparks to escape. When the engine "throws fire" from this cause the netting should be renewed. If the engine "works water" the netting is liable to get clogged. Unless oil from the cylinder gets into the netting the obstruction can usually be beaten out, but if the latter has oil in it, it can be burned out by building a fire on it, as explained in answer to Question 768.

QUESTION 901. *What should be noticed in connection with the steam and exhaust-pipes?*

Answer. The steam pipes should be kept tight. If they leak the joints must be reground. Exhaust nozzles sometimes get obstructed by a collection of oil and dirt, which should be cleaned out. It should also be noticed whether the nozzles are located so that the blast from the exhaust-pipes is discharged in the center of the chimney.

QUESTION 902. *To what casualties are the grates liable?*

Answer. To being burned out or broken. If this occurs bars must be renewed.

QUESTION 903. *How often should the tubes be cleaned?*

Answer. That depends very much upon the kind of fuel used, as some coal fills up the tubes much more than other kinds do. Every time the engine is washed out the tubes should be thoroughly cleaned. To do this the smoke-box must be opened and the exhaust or convey-pipes be taken down. If the fuel used leaves considerable deposit in the flues, it is well to brush them out as thoroughly as is possible from the furnace-door.

QUESTION 904. *How may a throttle-valve get out of order?*

Answer. They are liable to leak, and if they do they must be reground. A disconnected throttle is now a rare occurrence, but it should be certain that the connections are all right.

QUESTION 905. *What kind of attention must be given to the safety-valves?*

Answer. They should be adjusted so as to blow off at the required pressure, and it should be known whether the springs retain their elasticity, as it is affected by the heat of the steam, which makes it essential to renew them occasionally. One of the safety-valves should have a lever or other appliance for opening it in case it is necessary to relieve the boiler of pressure.

QUESTION 906. *What is essential with reference to steam gauges?*

Answer. Their most important function is to indicate the steam pressure correctly, and to be certain that they do this, they should be tested frequently. When this is done the date should always be marked on the back of the gauge, or some other record of it should be kept.

QUESTION 907. *What kind of attention should be given to the other boiler attachments?*

Answer. The whistle-valve should be kept tight, the gauge-cocks should be kept clear by running a wire through them, and the glass water-gauge should be blown out occasionally. A careful engineer will always know whether the injectors work satisfactorily, and if either of them is out of order it should be taken off and a spare one substituted in its place. Check-valves should be taken down occasionally and cleaned, and it should be observed whether the blower-valves and pipes are in good condition.

QUESTION 908. *What must be done to keep the insides of the cylinders in good condition—that is, to prevent them from cutting?*

Answer. They must be well lubricated when not using steam, and the packing must be properly set up, not so tight as

to bind nor so loose as to blow, or allow the piston-heads or followers to rub on the bottoms of the cylinders, as the two cast-iron surfaces will scratch each other. It is also important that the piston be central in the cylinder; if anything, have it a little higher than central. It should be set by callipering on the projection on the front side, which holds the follower-plate in place.

QUESTION 909. *What is meant by piston-packing being "follower-bound"?*

Answer. It means that when the follower-plate is bolted up hard against the piston-head that it clamps or binds the packing-rings between the plate and the piston-head so that the rings cannot move.

QUESTION 910. *How can it be known whether the packing is follower-bound?*

Answer. When the packing can move as it should between the piston-head and follower-plate its movement is usually shown by marks on the follower-plate when it is taken off. If such marks are not apparent, and there is reason to think that the packing is too tight, the piston should be taken out, the packing put in place, and the follower-plate bolted on. The packing should then be loose enough, so that it can be moved by tapping it with a piece of wood. If it is too tight a piece of paper should be inserted between the follower-plate and piston-head where they are in contact with each other.

QUESTION 911. *What kind of attention should be given to piston-rods?*

Answer. They should be oiled occasionally and kept keyed up tight in the cross-head and piston.

QUESTION 912. *What must be done to keep the cross-head slides and the guide-bars in good condition?*

Answer. They must be "in line" or parallel with the center line of the cylinder and they must be kept well lubricated. A little lost motion in the guides is not a serious evil unless it becomes excessive.

QUESTION 913. *What kind of attention should be given to the crank-pins and connecting-rods?*

Answer. They are all liable to break, and they should be examined often to see whether there are any cracks or flaws in them. Whenever the rods are taken down the straps should be looked over carefully, especially in the inside corners, to see whether any flaws exist. Main-rods are less liable to break than coupling rods. If there is any lost motion in the brasses of the main-rod they should be filed off on the faces, and keyed up so as to bear against each other hard without binding on the journal. They must be filed square, and the best plan is to put them on the journal and key them up in the strap alone without the rod. They can then be easily moved around the pin, to see whether they bind. Lost motion in a main connecting-rod will cause a thump, but a little play in coupling-rods will do no harm. It is better to have the bearings of coupling-rods too loose than too tight. If the coupling-rods have solid ends and bushings they require no attention excepting oiling, and when the bushings are worn too much they should be taken out and replaced with new ones.

QUESTION 914. *What must be done to keep oil cups in good condition?*

Answer. The principal thing to do is keep them clean, free from dirt and gum, and adjust the spindles—if they have any—so as to feed the right quantity of oil.

QUESTION 915. *How should the valve-gear be taken care of?*

Answer. The principal defects of valve-gear are due to want of proper lubrication. It should be examined carefully, and if there are any indications that the eccentric straps or any of the pins are cutting they should be taken apart, examined, and thoroughly oiled. It is usual now to key eccentrics fast to the axle so that it is impossible for them to slip. If they are fastened with set screws alone they should be examined occasionally to see whether they have moved from their original position.

QUESTION 916. *What is meant by an engine "going lame"?*

Answer. It means that one of the four blasts of steam from the cylinder are not equal, so as to give the sound of the exhaust an irregular or limping sound.

QUESTION 917. *To what cause is "going lame" generally due?*

Answer. It may be because one or more eccentrics are not set right or a valve-stem or eccentric-rod is too long or too short. Sometimes it is due to lost motion in the valve-gear, or the links may be suspended in such a way, that when the reverse-lever is in a given position one of them hangs lower than the other. To guard against the latter evil it should be observed, in setting the valves, whether they cut-off at the same points of the stroke on each side of the engine.

QUESTION 918. *What are the principal causes which make an engine "pound" or "thump"?*

Answer. It is generally due to lost motion somewhere. If an engineer hears a "knock," he should examine to see whether there is lost motion in either of the ends of the main connecting-rods. Lost motion in a coupling-rod is not liable to cause a thump, although they may be so loose that their side motion may make them rattle. Lost motion in the driving-boxes—that is, either in the bearings or wedges—a loose piston-rod in the cross-head or piston may cause a "pound." The most difficult cause to discover is when the piston-rod gets loose in the piston, because it cannot be examined when the engine is working. If a piston strikes the cylinder head it will also cause a "knock." By reversing the engine with a little steam on when it is standing still, it can be seen whether there is lost motion in the driving-boxes, and by watching them carefully it can be seen whether they are loose between the wedges or on the journal of the axle.

QUESTION 919. *How should the running-gear be taken care of while the engine is in the shop?*

Answer. First the journals of the axles must be kept well oiled. The oil-cellars should be taken down occasionally and cleaned. They should be packed with woolen waste, which has more elasticity than cotton and bears against the axle, while cotton waste packs down solid. With the heavy loads now carried on the driving-axles of some locomotives there is often much trouble from the journals heating. This is often due to the want of end play between the boxes and hubs and collars on the axles. This play should be about $\frac{3}{16}$ of an inch. The driving-boxes, tires, wheels, and axles should be examined often to discover flaws, as they are liable to break. Tires are most liable to split circumferentially or "bulge" sideways. An engineer should always be vigilant to detect circumferential flaws or any bulging, which usually indicates the beginning of a fracture. The breakage of engine axles usually occurs just inside of the hub. When the oil-cellars are taken down the portions of the axles which are inside of the box should be examined carefully for cracks or flaws.

QUESTION 920. *What precaution must be taken with reference to springs, hangers, and equalizers?*

Answer. Like all other parts, they should be examined often to see that they are in good condition, and it should be observed whether the springs come in contact with the boiler—if they are apt to rub against it and cut a hole in it.

QUESTION 921. *To what danger is the coupling between the engine and tender liable?*

Answer. The coupling-pins in time wear so much as to be seriously weakened, and draw-bars are liable to break, especially if they are not made heavy enough.

CORRECTION.

In the answer to Question 620, published in the number of the JOURNAL for February of this year, the fourth paragraph should be corrected so as to read as follows:

"To get a measure of the cylinder capacity which will also take the steam pressure into account, we should multiply the modulus of propulsion by the maximum boiler pressure per square inch. This product has been named the *modulus of traction*. Thus in the first example the boiler pressure was assumed to be 150 lbs., and therefore $3.68 \times 150 = 552$, in the second it was 140 lbs., so that $4.05 \times 140 = 567$. Experience seems to indicate that a modulus of traction of about 550 will give very good results in practice."

The error was in directing that the modulus of propulsion should be *divided* by the maximum boiler pressure instead of *multiplying* it.

(THE END.)

Manufactures.

Manufacturing Notes.

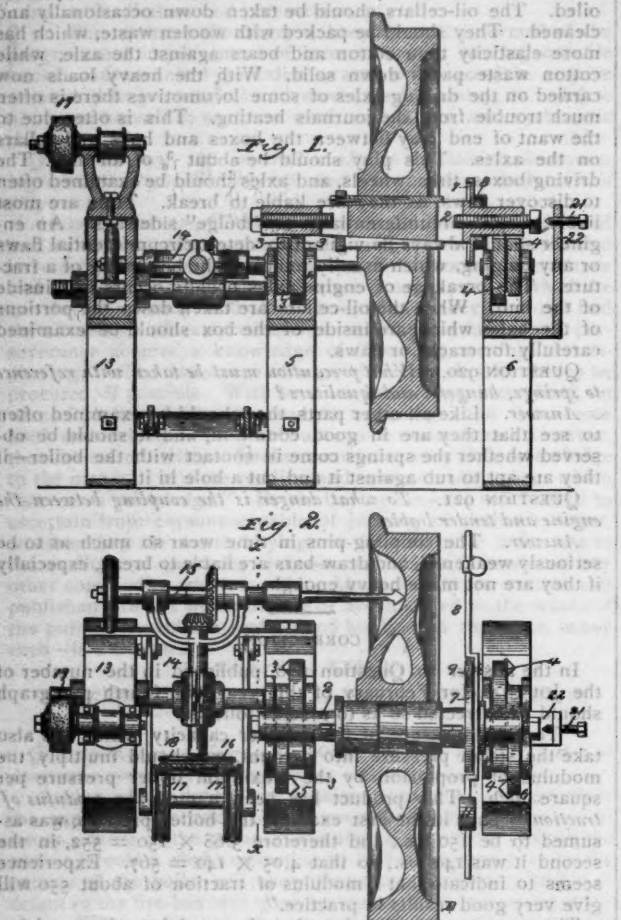
THE Pond Engineering Company, St. Louis, has plenty of business on hand. The Company has recently sold an Armington & Sims engine of 125 H. P. to the Electric Light Company, Fort Scott, Kan.; also a 50-H. P. engine, with an inside steam condenser, etc., to a firm in Milford, Ia. The Company has a contract for the engine and boilers for the water-works at Belleville, Kan., and has furnished leather-link belting to the Edison Illuminating Company, Topeka, Kan., and a Tracey oil filter to the Metropolitan Railroad, Kansas City. Its latest contract is for an Armington & Sims engine of 100 H. P. for the Water & Light Company at Hutchinson, Kan. This engine has a special feature—a clutch placed on the driving-wheel so arranged

that with the engine running steadily the driving-wheel can be run as desired.

THE Llewellin Machine Company, Bristol, England, is making a time-checking machine which has met with much success there, and is now being introduced in this country by E. P. Spaulding & Company, of New York. This contrivance registers the time of arrival of each workman in the shop, the man putting a check, with his number or some other mark, into a slot in the machine. One of these contrivances has been in use some time in the Crump Label Works at Montclair, N. J., where some 300 men are employed, and no mistake has ever been detected.

ARRANGEMENTS have been made to supply the city of Fort Wayne, Ind., with natural gas brought from wells 40 miles distant from the city. The pipes will be laid on the right of way of the Fort Wayne, Cincinnati & Louisville Railroad.

THE shops of Pedrick & Ayer, in Philadelphia, have become entirely too small for their increasing business, and the firm have therefore removed from their old quarters to new shops at 1,001 and 1,003 Hamilton Street, and 1,002 and 1,004 Buttonwood Street, Philadelphia, where they have now ample facilities for turning out a large quantity of work and filling all orders.



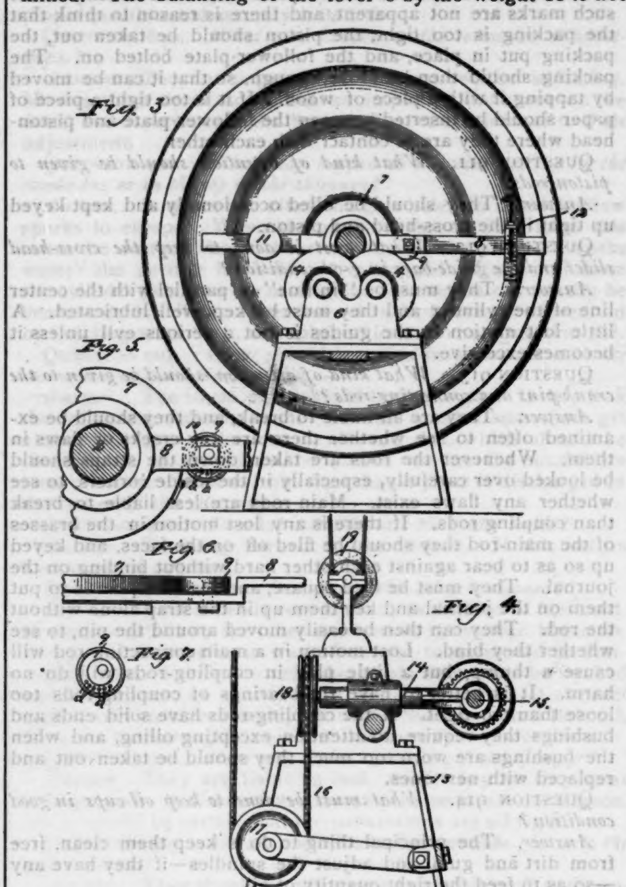
Balancing Apparatus for Wheels.

THE accompanying illustrations show an apparatus for balancing wheels, pulleys, etc., recently invented by Thomas A. Griffin, of Chicago, and covered by patent No. 407,589, issued under date of July 23 last.

The wheel is mounted for balancing upon an expanding mandrel, though an ordinary mandrel will answer.

In the accompanying drawings, fig. 1 is a vertical longitudinal section of the improved apparatus, showing a car-wheel in position for balancing. Fig. 2 is a plan view of the apparatus, the car-wheel being shown in section. Fig. 3 is an elevation looking from the right of fig. 2. Fig. 4 is an elevation of the part to the left of the dotted line *x x*, fig. 2. Figs. 5, 6, and 7 are detail views on an enlarged scale.

The ends of the mandrel 2 rest on anti-friction rollers 3 3 4 4, journaled in the standards 5 6, which constitute a part of the frame of the machine. A disk 7 is rigidly secured to the mandrel 2, and a lever 8 is hung thereon so that it may vibrate in proximity to the disk. Upon the lever 8 is pivoted an eccentric 9, whose edge is in contact with the edge of the disk 7. The structure of the eccentric 9 is shown in figs. 5, 6, and 7. A curved or coiled spring 10 (seen in dotted outline in fig. 5), one of its ends being inserted in one of the holes *a a*, etc., in the eccentric, and the other end in the arm or lever 8, maintains the contact between the disk 7 and eccentric 9. The eccentric 9 is thus adapted to act as a friction-clutch, and is arranged so that when the lever 8 is moved in the direction of the arrow, fig. 3 or 5, the disk 7 and the attached mandrel and pulley or wheel will be rotated, while the lever will be freed when moved in the opposite direction. The lever 8 projects on both sides of the mandrel 2, one end being provided with a balancing-weight 11, by which the lever itself may be poised, while the other end is provided with a spring-scale 12, or other device, by which the force applied in turning the mandrel and pulley may be determined. The balancing of the lever 8 by the weight 11 is not



essential, as will be evident when the operation comes to be considered; but is a convenience, because the scale will then correctly indicate the force required to rotate the mandrel.

Mounted at the rear of the apparatus between the standards 5 and 13, figs. 1 and 2, is a drilling-machine 14, the drill-spindle 15 of which is made adjustable by well-known devices, so that it may be fixed at any angle or in any position within its range. Power for driving the drill is transmitted through the rope 16, passing round the pulley 18 and tightener-pulleys 17, figs. 2 and 4. An emery-wheel 19 is also mounted at the rear of the machine, and is used for fitting and reducing the counterbalance-weight when the precise weight needed has been ascertained.

The mode of using the apparatus hereinabove described is as follows: The mandrel 2 is driven into the wheel or pulley to be balanced and placed upon the rollers 3 3 4 4. The spring-scale 12 is slid along the lever or scale beam 8 to any convenient point, varying with the size and weight of the pulley operated upon, but preferably to a position corresponding to the radial distance proposed for the counter-weight. Pressure barely sufficient to turn the mandrel is applied to the spring-scale and its reading noted. Another portion of the pulley or wheel is then brought uppermost and the pressure required to turn it again noted. Several diametrically opposite points are thus tested. As the frictional resistance is the same for all

positions, the comparison of the different readings will show the location of the heaviest spot, and one-half the difference between the greatest and least opposite readings will be the amount of counterbalance needed if placed at the radial distance of the weighing-scale. A weight of the proper size, being selected or prepared by grinding on the wheel 19 or otherwise, is then temporarily secured to the pulley or wheel, and if desired its sufficiency tested by noting whether the pressure required to revolve the wheel is the same in all positions. The counterbalance-weight is then permanently secured by drilling through it and the wheel before the latter is removed from the balancing-machine and inserting a rivet or other fastening. The thrust of the drill against the wheel is taken by the screw 21, passing through the brace 22, figs. 1 and 2, and abutting against the end of the mandrel.

Soule's Rail-Joint.

MR. RICHARD H. SOULE, of Pittsburgh, Pa., has patented the rail-joint illustrated herewith, which is described as follows in his specification :

" In the accompanying drawings, forming a part of this specification, fig. 1 is a view in elevation of a rail-joint having my invention applied thereto. Fig. 2 is a view of the same, partly in section and partly in elevation. Fig. 3 is a sectional elevation on the line *x x*, fig. 1 ; and fig. 4 is a similar view on the line *y y*, fig. 1.

" In the practice of my invention the wings 1, formed on opposite sides of the box 2, are supported by adjacent cross-ties 3, the box hanging, as it were, between the ties, as shown in figs.

FIG. 1.

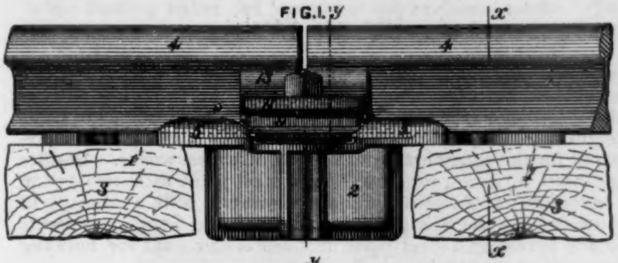


FIG. 2.

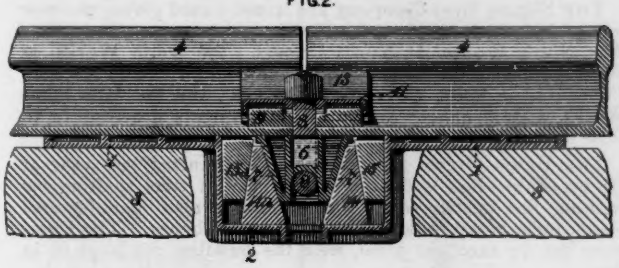


FIG. 3.

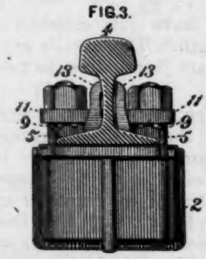
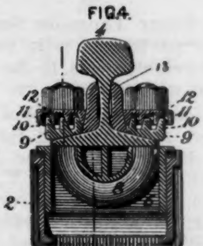


FIG. 4.



1 and 2. The adjacent ends of rails 4 are arranged on the wings 1, the plane of contact of the rail ends coinciding, approximately, with a plane passing transversely through the middle of the box 2, which, as shown in figs. 2 and 4, is open on its upper side, the rails being guided into line with each other by flanges 5, formed on the edges of the wings 1, at or adjacent to the points of junction with the box 2, as shown in figs. 1 and 3, said flanges also serving to strengthen the wings at that point.

" Beneath the ends of the rails is arranged a block 6, having inclined outer faces 7 and a curved seat for the reception of the U-shaped bolt 8, whose threaded ends project up through suitable notches in the flanges of the rails on opposite sides of the web. On top of the rail-flanges I place plates 9, having upwardly-projecting teeth or ribs 10, with inclined inner faces, as shown in fig. 4, and on top of the plates 9, I place plates 11, provided with downwardly-projecting ribs 12, having inclined outer faces, the ribs 12 alternating with the ribs 10. The plates 11 are made of such a width that when the inclined faces of the ribs 10 and 12 partially engage each other, the inner edges of the plates 11 will bear against the splice-bars 13, arranged against the webs of the rails and overlapping the ends thereof, as shown in figs. 1 and 2, and as the plates 11 are pressed down by the nuts on the U-shaped bolts 8, said plates and the splice-bars will be forced tightly against the webs of the rails, holding the latter in perfect alignment. Within box 2 and on opposite sides of the block 6 are placed the oppositely-arranged wedge-blocks 14 15 and 14^a 15^a, as shown in fig. 2, the inner faces of the blocks 14 14^a coinciding as to inclination with the faces 7 of the blocks 6 and the adjacent faces of the blocks 14 15 and 14^a 15^a also coinciding as to inclination, while the outer faces of the blocks 15 15^a are made straight, fitting the sides of the box 2. As shown in fig. 2, the adjusting wedge-blocks 15 15^a, operating by gravity, tend to force the blocks 14 14^a inwardly against the rail-supporting block 6, and also hold said blocks 14 14^a as against any outward movement when operated on by the block 6, the taper of the adjusting-blocks being such as will not render them liable to be raised when pressed upon by the adjustable blocks 14 14^a. It will be observed that the adjusting-blocks 15 15^a operate solely through gravity, the flange of the rails not having any bearing on their ends.

" In adjusting my improved joint to the rails the adjustable blocks 14 14^a are first placed in position, then the supporting-block is arranged between them, and the adjusting-blocks 15 15^a are finally pressed between the sides of the box and the blocks 14 14^a. The rails are then placed and secured in position by the U-shaped bolt, the plates 9 and 11 and splice-bars 13, as hereinbefore described. As a load passes along a rail having its ends supported by my device, the weight will cause a slight depression of the middle portion of the rail and a corresponding elevation of the ends of said rail. As the ends of the rails rise, the block 6 will be lifted up away from the adjustable blocks 14 14^a, which will then be moved inward against the block 6 by the adjusting-blocks 15 15^a, thereby preventing any downward movement or deflection of the rail ends when the load comes upon them. This automatic adjustment of the rail ends will continue until said ends have been raised to a normal level, no further elevation occurring, except such as may be necessary to compensate for the settling of the cross-ties."

Blast Furnaces of the United States.

THE *American Manufacturer* gives its usual monthly table, showing the condition of the blast furnaces on September 1, and says : " In a condensed form the showing is as follows :

Fuel.	In Blast. No.	In Blast. Weekly capacity.	Out of Blast. No.	Out of Blast. Weekly capacity.
Charcoal	69	11,769	96	13,228
Anthracite	94	35,497	95	24,438
Bituminous	137	92,915	111	52,719
Total	300	140,181	302	90,385

" As compared with one month ago there has been a marked increase in the total number of furnaces in blast, though not so great a relative increase in capacity.

" As compared with one year ago the position of the furnaces is as follows :

Fuel.	Sept. 1, 1889. No.	Sept. 1, 1889. Weekly capacity.	Sept. 1, 1888. No.	Sept. 1, 1888. Weekly capacity.
Charcoal	69	11,769	68	12,623
Anthracite	94	35,497	98	28,946
Bituminous	137	92,915	132	84,513
Total	300	140,181	298	126,082

" This table shows some considerable changes during the year."

Bridges.

THE Berlin Iron Bridge Company, East Berlin, Conn., has taken a contract for the iron bridge at Fall River, Mass. It will be a deck bridge.

THE Chicago Bridge & Iron Company has been incorporated to make bridges and similar kinds of construction work ; capital, $100,000 ; incorporators, George H. Wheelock, Horace E. Horton, and William B. Wheelock.

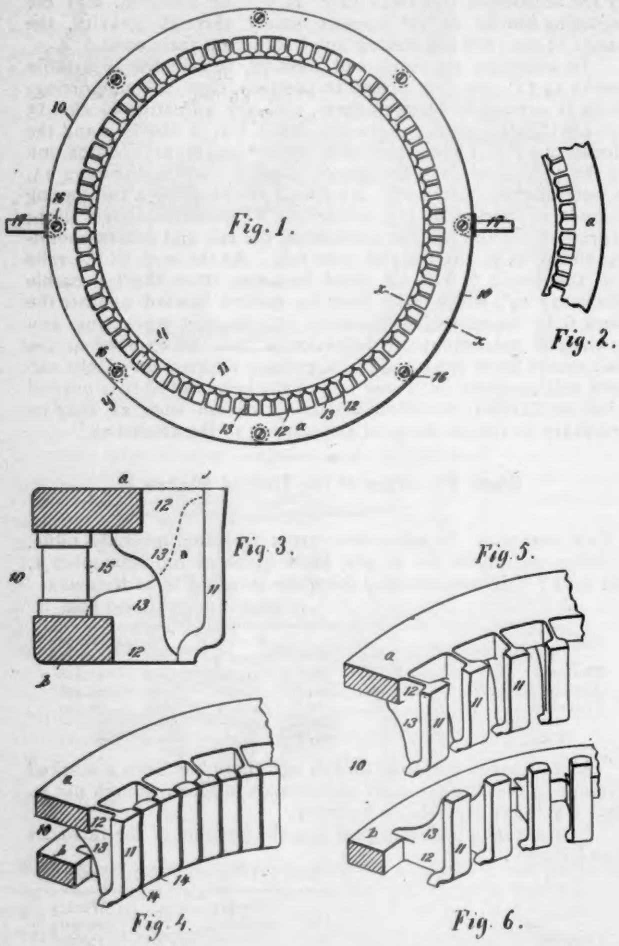
THE R. F. Hawkins Iron Works, Springfield, Mass., have taken a contract for the iron highway bridge over the Acushnet River in New Bedford, Mass. The contract price is $19,000.

THE Schiffler Bridge Company, Pittsburgh, Pa., has taken the contract to build a railroad bridge over the Casey Creek near Nicholasville, Ky. The bridge will be 600 ft. long, and the contract price is $100,000.

THE Phœnix Bridge Company, Phœnixville, Pa., is building two iron bridges of 150 ft. span for the Columbus Southern Railroad in Georgia, and will soon begin work on iron bridges for the Alabama Midland at Montgomery, Ala., and for the Nashville, Chattanooga & St. Louis Railroad over Stone River in Tennessee.

Chill-Mold for Casting Car Wheels.

THE ordinary chill-mold in which car-wheels are cast consists of an iron ring, the inner surface of which forms the mold for the tread of the wheel. The melted iron when it comes in contact with this is cooled suddenly and "chilled," which gives the tread the requisite hardness to resist wear. The difficulty with this form of chill is that the melted iron in coming in contact with it heats and expands it, and that in cooling the iron contracts, and thus the mold and the iron inside of it are drawn away from each other by the expansion and contraction. To get over this difficulty "contracting chill-molds," as they are called, have been devised. These have an outer ring, with projections which are attached to it, and project inward toward the center of the chill, the inner surfaces of these projections forming the tread of the wheel.



The illustrations herewith represent an improved chill-mold of this kind, which has recently been patented by Mr. Ferdinand E. Canda, of New York City. Fig. 1 is a plan, and fig. 3 a vertical section on *a b*, the latter on a larger scale than fig. 1. The chill-mold consists essentially of two or more outer rings, *a b*, fig. 3, and an inner ring 11 made to conform to the tread of the wheel and subdivided into sections that are connected alternately to the outer rings by brackets or webs 13, one end only of each section being connected to its outer supporting-ring, the webs or brackets being formed to properly brace and hold the sections constituting the inner ring. In practice the two or more outer rings would be held apart and spaced by struts or separators 15 that are bolted to place between the rings, and the chill would be made up of an inner compound ring wherein the ring members are divided by vertical or oblique lines of separation. Fig. 4 is a perspective view looking at the inside of a portion of the chill-mold, and in figs. 5 and 6 the two rings are represented as they appear when moved apart. From these it will be seen that the blocks 11, 11 are alternately connected to the auxiliary rings *a* and *b*. In constructing the chill-mold the inventor says he prefers to cast it in one piece, arranging the cores so that they come in proper places, and afterward to divide the sections or blocks forming the inner ring by means of a saw or any other known tool applicable for such work, the saw-kerfs 14 between the sections being about one thirty-second of an inch in width, more or less. Prior to the division just spoken of, he places struts or separators 15 between the auxiliary rings constituting the compound outer ring 10, such struts being held to place by bolts 16, which pass through the auxiliary rings and through the struts or separators: or, if desired, the struts 15 could be cast with the chill and become an integral part thereof. Two of the struts or separators are provided with trunnions 17.

Such a chill as the one above described overcomes the difficulty presented in a chill formed with a solid outer ring, as the expansion of the webs or brackets by which the inner sections are supported will tend to decrease rather than increase the inner peripheral face of the chill, and as the outer ring is divided and exposed to the surrounding atmosphere it will not become unduly heated, as would be the case if it were formed from a solid mass of metal, adequate egress being provided for the heat, gases, and vapors generated in the process of casting the wheel within the chill.

Iron and Steel.

THE Pennsylvania Steel Company some time ago built two new blast furnaces near Baltimore, the object being to have those furnaces at a point where the ore from its mines in Cuba might be readily delivered by ships. Plans have now been prepared for the considerable extension of those works. Besides the blast furnaces, there will be a steel plant with two 15-ton converters; a blooming mill and a rail-mill with a capacity of 1,000 lbs. of steel rails per day. To these the Company expects to add hereafter a steel plate mill and a ship-yard for building iron and steel vessels.

THE Illinois Steel Company has issued a card giving the new names by which their various mills are known. They are: The North Works, at North Chicago; the South Works, at South Chicago; the Union Works, on South Ashland Avenue, Chicago; the Joliet Works, at Joliet, Ill., and the Milwaukee Works, at Milwaukee, Wis. All departments are running to their full capacity.—*Industrial World.*

THE Union Drawn Steel Company, organized last year at Beaver Falls, Pa., is making a specialty of steel shafting for running fine machinery. The Company also manufactures piston-rods, pump-rods, guides, and steel shapes. The Company has an excellent plant, with the building 225 × 50 ft. in size.

THE Edgar Thomson Steel Works have just finished an order for 500 tons of rails, 60 ft. in length. These rails are of unusual weight, 85 lbs. to the yard, and are just double the usual length to which rails are cut.

THE Continental Iron Works, Brooklyn, N. Y., have recently furnished 24 corrugated furnaces for the new Government cruiser *Maine;* 12 for the Morgan Iron Works; 12 for the Quintard Iron Works, N. Y., and a number for other parties. They are also making six corrugated flues, 36 in. diameter and 6 ft. long, for a steamer which is being built by the Dry Dock Engine Works, Detroit, and several flues, 40 in. diameter and 18 ft. long, for the boilers of the Duluth Electric Light station.

THE stockholders of the Thomas Iron Company, at Hokendauqua, Pa., have authorized the directors to complete the agreement for the sale of the works to English parties, who, it is understood, are the same who recently bought the Otis Steel Works at Cleveland.

Marine Engineering.

THE Pusey & Jones Company, Wilmington, Del., is building two stern-wheel steamboats to run on the Indian River in Florida. One of these boats will be 130 ft. long, 24 ft. wide, and 4 ft. deep, with compound engine having cylinders 14 in. and 30 in. diameter, and 60 in. stroke. The other boat will be 110 ft. long, 28 ft. wide, and 4 ft. deep, with a compound engine having cylinders 11 in. and 24 in. diameter and 48 in. stroke. These boats will draw only 18 in. of water when loaded.

Locomotives.

THE Pennsylvania Company's shops at Fort Wayne, Ind., are building 11 consolidation locomotives of class S for the road.

THE Rogers Locomotive Works, Paterson, N. J., are building six engines for the Sioux City & Northern Railroad.

THE Pennsylvania shops at Altoona, Pa., are building 17 very heavy passenger locomotives for use on the New Jersey divisions.

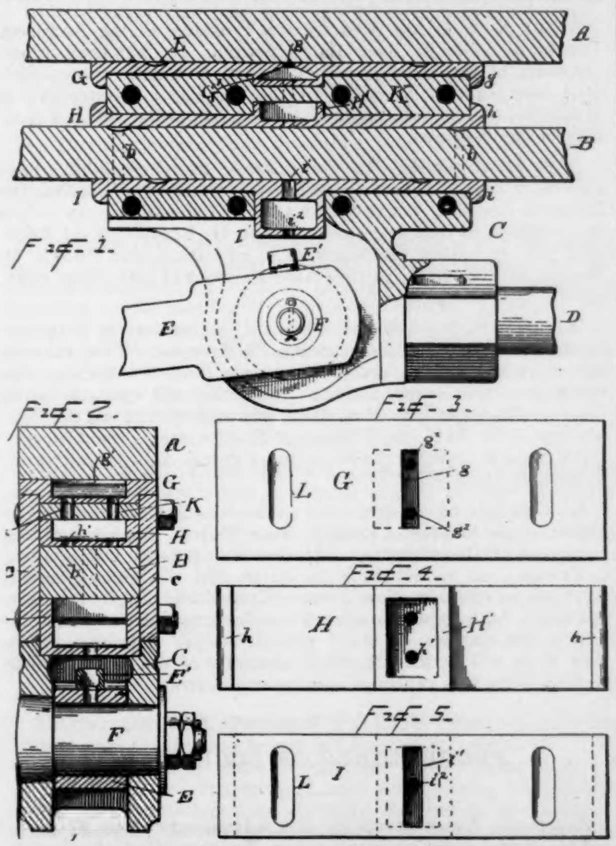
ALL the machinery in the Hinkley Locomotive Works in Boston has been sold. About two-thirds of it was sold at private sale, and the remainder at auction. The property occupied by the works has also been sold and will be used for the electric plant for the West End Railroad Company.

THE Portland Company, at Portland, Me., has resolved to continue the manufacture of locomotives in spite of reports which had been circulated to the effect that the business was to be given up. Some changes are to be made with the view of cutting down the expenses as much as possible. Besides locomotive work, the shops are doing a good deal of marine engine and repair work.

Improved Cross-Head.

MR. LOWELL H. KENYON, of Alleghany, Pa., has patented a cross-head, which is illustrated by the engravings herewith. He describes his invention as follows in his specification:

"In a locomotive which runs for the most part in a forward direction the effect of the inclination of the connecting-rod is to cause the cross-head to press upward, when propelled by steam, when making either the forward or the backward stroke. This brings the wear upon the upper gib. With the increase in boiler-



pressures and the larger cylinders now coming into use, the pressure on the cross-head gibs is becoming much greater than heretofore, and consequently it is necessary to provide a larger wearing-surface to keep the friction down to the proper limit and prevent excessive wear and heating. A better mode of oiling the gibs and guides is also desirable. Both of these objects I have aimed to accomplish in my improved cross-head.

"I make use of the ordinary two-bar guide, and provide the cross-head with the usual gibs, one bearing against the under side of the upper bar, and the other bearing on top of the lower bar. I add to these another gib bearing against the under side of the lower guide-bar. This gives the cross-head three gibs, the top and bottom ones bearing against the under sides of their respective guide-bars and the middle one resting on top of the lower guide-bar. The top and bottom gibs, however, sustain the thrust of the connecting-rod, and as their combined bearing-surfaces are nearly double the area of the single gib ordinarily used, it is evident that the wear per square inch is reduced by nearly one-half and the friction is similarly greatly lessened. I also provide the gibs and guides with oil-holes and chambers, whereby the oil is more evenly distributed, is fed from the top gib through to the bottom gib and thence to the cross-head pin, and the guides are kept oiled when the engine is at rest.

"In the drawings, fig. 1 is a vertical longitudinal section of a two-bar guide and a cross-head embodying my improvements. Fig. 2 is a cross-section thereof through the cross-head pin, and the other figures are detail views of the gibs."

Cars.

THE St. Charles Car Company, St. Charles, Mo., is building 30 passenger cars for the Rio Grande Western Railroad.

THE Pullman Car Works, Pullman, Ill., have orders on hand for about 1,000 freight cars, including a large number of box cars for the Georgia Pacific Railroad.

THE Wells & French Company, of Chicago, are building 500 box stock and coal cars for the Rio Grande Western Railroad.

THE Erie Car Works, Erie, Pa., are building 100 coal cars for a New England road, 100 for the Rainey Bank Coal Company, and 300 for the Pennsylvania Railroad.

THE Pennsylvania Company's shops at Fort Wayne, Ind., are building 100 refrigerator cars for the Pittsburgh, Cincinnati & St. Louis Railroad. These cars are of the same pattern as 100 completed for that line a short time ago.

THE Minnesota Iron Car Company has been incorporated successor of the Minnesota Car Company. The incorporators are John F. T. Anderson, W. E. Tanner, and Joseph R. Anderson, of Richmond, Va., and George W. Ettinger, of New York. Its capital will be $2,000,000.

Some New Railroad Shops.

THE Long Island Railroad Company is building new shops near Jamaica, N. Y., to take the place of the old repair shops at Hunter's Point, which are now too small for the needs of the road. The new buildings are of brick, with granite foundations and trimmings. They consist of two large main structures, running north and south, respectively 547 × 85 ft. and 420 × 100 ft.; a blacksmith shop 100 × 60 ft.; a boiler-house 35 × 45 ft.; an engine-room 26 × 45 ft., and a store and pattern-room, all separate from each other, and a chimney or smoke-stack between the boiler-house and blacksmith shop 125 ft. high and 16 ft. in diameter at the base.

While the new works will not be the largest in the country, they will be among the most complete in design and appointments. The total cost will be about $175,000. The contract for building them was given to the Flynt Building & Construction Company, of Palmer, Mass. The architect was L. H. Gager, of Palmer, Mass., and the Company's Chief Engineer, Anthony Jones, had charge of the work. The immediate supervision, however, of the details in the construction of the new buildings and fitting them up, was intrusted to Charles A. Thompson, Master Mechanic of the Long Island Railroad.

The big building is divided into three: A paint shop 239 ft. long, containing 14 tracks running across the building, so that 14 cars can be worked upon at once; a car-building shop 214 ft. long, with 13 tracks, and a mill-room 89 ft. long, where the lumber will be planed and prepared. These three shops are the full width of the building—85 ft. The building is 30 ft. high inside to the center of the roof. The flooring consists of a combined Trinidad and Neufchâtel asphalt pavement.

The machine shop, 420 ft. long by 60 ft. wide, with an annex 40 ft. wide running the entire length, in which is placed the various machinery, contains 16 tracks and pits. The building has a truss roof, and is well lighted. It is fitted with two traveling cranes of a joint capacity of 50 tons, which combined can pick up an engine and transfer it easily over other engines in the building from one part of the shop to another. The cranes are laid on the trusses and sustained at both ends; they were built by the Morgan Engineering Company, Alliance, O.

The smiths' shop will contain a large furnace, two steam-hammers, each having a head weighing 1,200 lbs., and 13 forges. It is unusually well lighted and ventilated.

Power for the shops is furnished by three Westinghouse compound automatic engines of 225 H. P. The boilers are built by the Bigelow Company, New Haven, Conn.

In addition to the tools transferred from the old shops, these shops will have a number of new tools, including cylinder-boring

machines, driving-wheel lathes, planes, etc., the contract for which was taken by Manning, Maxwell & Moore, New York.

Between the two main buildings will be an immense transfer-table 78 ft. long, for the purpose of transferring engines and cars in and out of the shops. It will rest on eight tracks and is being made by the Yale & Towne Manufacturing Company.

In addition to the buildings mentioned, there will be a round-house 300 ft. in diameter, with stalls for 50 locomotives.

OBITUARY.

CAPTAIN JAMES REES, the celebrated boat-builder, died at Pittsburgh, Pa., September 12, aged 69 years, of asthma, after a prolonged illness. Captain Rees was the first manufacturer to make a steel-plate river boat.

JAMES H. MORLEY, of St. Louis, a well-known civil engineer, died September 12, at Windsor, N. Y., after a long illness. He was 65 years old, and was born in New York. He was Chief Engineer of the Missouri Pacific Railroad.

WILLIAM H. CILLEY, the associate of Henry Meiggs in the construction of the celebrated Lima & Oroya Railroad, died September 10 at Lima, Peru. Leading residents of Lima and the School of Engineers attended the funeral, and a great number of business houses were closed as a mark of respect.

JOHN COFFIN, Chief Engineer of the Johnson Company, of Johnstown, Pa., died in that place September 3. Mr. Coffin was born at Chatham, N. Y., on September 18, 1856. He studied engineering at Cornell University, and subsequently took charge of a machine-shop at Syracuse, N. Y. In 1881 he located at Johnstown, securing a position in the drafting d - partment of the Cambria Iron Works, and later entered the service of the Johnson Company.

PROFESSOR GEORGE H. COOK, who died suddenly at his home in New Brunswick, N. J., September 22, was born in Hanover, N. J. About 1836 he began work as a civil engineer, and was employed to lay out the line for the old Catskill & Canajoharie Railroad. He was not, however, satisfied with his attainments, and entered the Rensselaer Polytechnic Institute, graduating in 1839. He afterward became a teacher in the Institute, and in 1842 was made Senior Professor, a position equivalent to the Presidency. He afterward became Professor of Mathematics and Natural Philosophy in the Albany Academy. In 1850 he became Principal of the Academy, and held the office two years, leaving on his election to the Chair of Chemistry and Natural Philosophy in Rutgers College. The next year he was made Assistant Geologist of New Jersey.

The office of State Geologist had been allowed to lapse for several years, but a paper by Dr. Cook led to its reorganization, and in 1864 he was made its head. His work as State Geologist has been varied and of great importance. The topographical maps of the State which have been published under his supervision have been adjudged the best of any published by the different States. The last of the series was recently issued, and Dr. Cook was at the time of his death engaged on his final report. Two volumes had been prepared, the latter now being in print.

In 1864 the State Agricultural College was attached to Rutgers, and Dr. Cook, while retaining his professorship, became Vice-President of the college. He was the organizer of the State Board of Agriculture, and having been for a long time its Secretary, became in 1886 Chief Director of the New Jersey State Weather Service. He was long President of New Brunswick's Board of Water Commissioners, was a member of the State Board of Health, and held many minor offices in the State. He had been active also in work elsewhere. In 1852 he was sent to Europe by the State of New York to make investigations that might aid in developing the Onondaga salt springs. He went again to Europe in 1870 to study certain geological subjects, and in 1878 was a delegate to the International Geological Congress held at Paris in connection with the French Exposition.

Dr. Cook was a member of the American Association for the Advancement of Science and the author of many papers and addresses. He received the degree of Ph.D. from the University of New York and of LL.D. from Union College. He was a most unostentatious man, very plain in address, but a persistent worker and an indefatigable collector, as the State Museum at Rutgers bear witness. He leaves a widow and two children, one son and one daughter.

PERSONALS.

E. T. JEFFREY has resigned his position as General Manager of the Illinois Central Railroad.

JAMES G. DAGRON has been appointed Engineer of Bridges of the Baltimore & Ohio Railroad.

COLONEL WILLIAM F. SWITZLER has resigned his position as Chief of the Bureau of Statistics in the Treasury Department.

A. P. GEST, late Assistant Engineer New York Division, Pennsylvania Railroad, has been appointed Superintendent of the Bedford Division.

WILLIAM MAHL has been appointed Assistant to the First Vice-President of the Southern Pacific Company, with office at No. 23 Broad Street, New York.

WHEELOCK G. VEAZEY, of Vermont, has been appointed a member of the Interstate Commerce Commission, to succeed A. F. WALKER, resigned. Mr. Veazey is a lawyer and judge of good standing, and a competent and able man.

M. S. BELKNAP, it is reported, has resigned the office of General Manager of the Central Railroad of Georgia, to accept a position in Mexico. It is said that he will be succeeded on the Central by CECIL GABBETT, now General Manager of the Western Railroad of Alabama.

CHARLES BLACKWELL has been appointed Assistant Superintendent of the Toledo, St. Louis & Kansas City Railroad, with general supervision of the mechanical department and train service. Mr. Blackwell has had extensive experience in the locomotive department, and is exceedingly well qualified for the position.

ALLEN MANVEL has been chosen President of the Atchison, Topeka & Santa Fé Railroad Company. He has been Superintendent of the Chicago, Rock Island & Pacific, Superintendent and General Manager of the St. Paul, Minneapolis & Manitoba, and is well qualified for the somewhat difficult position he has assumed.

JOHN H. JONES and DR. CHARLES A. ASHBURNER have been appointed special agents to collect the statistics of coal for the Eleventh Census ; JAMES M. SWANK, of Philadelphia, to collect the statistics of iron and steel ; JAMES H. BLODGETT, of Rockford, Ill., to collect the statistics of education, and JOSEPH D. WEEKS, of Pittsburgh, to collect the statistics of petroleum, coke, natural gas, and glass.

WILLIAM B. STRONG has resigned his position as President of the Atchison, Topeka & Santa Fé Railroad. Few railroad men have had a more varied experience than Mr. Strong, who has held almost every position from telegraph operator up to General Manager and President, and has served on the Milwaukee & St. Paul, the Chicago & Northwestern, the Chicago, Burlington & Quincy, the Michigan Central, and the Atchison, Topeka & Santa Fé.

HORACE SEE has resigned his position as Superintendent Engineer of the William Cramp & Sons Ship & Engine Building Company in Philadelphia. Mr. See is at present taking a trip in Europe ; on his return in the latter part of October, he will establish an office in New York as Consulting Engineer. Mr. See has a high reputation as a marine engineer, and has designed the engines of many notable ships. His removal to New York will be an additional insurance of the pre-eminence of New York as a center of marine engineering.

PROCEEDINGS OF SOCIETIES.

American Association for the Advancement of Science.—The annual meeting was held in Toronto, Ont., beginning August 28 and ending September 3. Some 200 new members were elected.

Among the papers read in the Section of Mechanical Science and Engineering were : Preservation of Timber, by O. Chanute ; Air Compressors, by J. E. Denton ; Long Span Bridges, by Gustav Lindenthal ; Pumps and Injectors, by E. B. Perry.

A very interesting paper by J. Richards Dodge treated the question of Irrigation at considerable length.

The following officers for the ensuing year were elected : President, George L. Goodall, Cambridge, Mass. ; Vice-Presidents, S. C. Chandler, Cambridge, Mass., mathematics and astronomy ; Cleveland Abbe, Washington, physics ; R. B. Warder, Washington, chemistry ; James E. Denton, Hoboken,

N. J., mathematical science and engineering; John S. Brauner, Little Rock, Ark., geology and geography; C. S. Minot, Boston, biology; Frank Baker, Washington, anthropology; J. R. Dodge, Washington, economic science and statistics. Permanent Secretary, F. W. Putnam, Cambridge, Mass. General Secretary, H. C. Bolton, New York. Secretary of Council, James Landon, Toronto. Treasurer, William Tilly, Mauch Chunk, Pa.

The Association will meet next year at Indianapolis on the third Wednesday in August.

Association of North American Railroad Superintendents.—The Eighteenth Meeting will be held at the Hotel Brunswick, New York City, October 7 next, at 11 A.M.

Matters of importance to come up at this meeting are the relations of the Association to the General Time Convention; its relations to other organizations of railroad men, and the adoption of an amended constitution.

The Committee on Roadway will report on Rail Sections, and also on the award of the prize for the best treatise on Trackwork; the Committee on Machinery will report on Steam Heating of Trains and on Train Signal Apparatus; the Committee on Transportation will report on Uniform Forms for Time-tables and on Methods of Discipline.

All railroad superintendents are invited to attend the meeting and to join the Association.

Roadmasters' Association of America.—The annual convention began at Denver, Col., September 11, with a very good attendance.

The leading subject of discussion was rail-joints, on which papers were presented by Messrs. Burnett, Delano, and others.

Reports were also presented and discussions had on Frogs; Track Labor; Switch-stands, and Protection of Facing Points; Track Tools; and on Cattle-guards.

It was decided to hold the next convention in Detroit.

The following officers were chosen for the ensuing year: President, John Sloane; Vice-Presidents, W. H. Courtney, John Doyle; Secretary and Treasurer, John C. Ramsey; Member of Executive Committee, George E. Cain. The address of the Secretary is Connersville, Ind.

American Institute of Mining Engineers.—The 55th meeting of the Institute begins at Ottawa, Canada, October 1, continuing throughout the week. The programme includes business meetings for the reading of papers on Tuesday, Thursday, and Friday; excursions to the Phosphate Mines near Ottawa, to the Copper Mines at Sudbury, and other points of interest in the neighborhood. Those members who desire to do so will be taken from the Canadian Pacific Railroad to Port Arthur and the Silver Mines on the north shore of Lake Superior.

New England Road-Masters' Association.—The seventh annual Convention began in Boston, August 21, and continued for three days. Reports were presented by the Committees on Track Repairs; on Cattle-guards and on Fences—all of which called out much discussion, especially that of the Committee on Cattle-guards.

It was decided to hold the next Convention in Boston. The following officers were elected for the ensuing year: President, G. W. Bishop; Vice-President, W. E. Clark; Chaplain, J. S. Lane; Secretary and Treasurer, W. F. Ellis.

Master Car & Locomotive Painters' Association.—The 20th annual Convention began in Chicago, September 11. The reports show an increase in members, there being now 132 active members. Papers were read on Painting the Heating Parts of Locomotives; on Painting the Inside of Passenger Cars; on the Use of Varnish on Cars; on Decorating Cars and Locomotives, and on the Time which the Locomotive should run before being repainted. All these papers were discussed by the members present, and on several of them, letters and reports were received from absent members.

It was decided to hold the Convention next year in Boston. The following officers were elected for the ensuing year: A. E. Barker, President; William Lewis and E. G. Fetting, Vice-Presidents; Robert McKeon, Secretary and Treasurer.

American Society of Civil Engineers.—A regular meeting was held in New York, September 4. A paper by John F. Wallace on the Sibley Bridge was read.

H. C. Miller gave an account of his experiences in Nicaragua, and of the work done on the surveys of the canal.

The tellers announced the following elections: *Member*, Bushrod W. Taylor, Louisville, Ky.; *Junior*, Mario Lorini, New York.

Engineers' Club of St. Louis.—At the regular meeting, September 11, a letter from the Committee of the American Society of Civil Engineers on revision of the constitution was read. The Executive Committee presented a report recommending the appointment of the Committee to consult with the Committee of the American Society and with other clubs on the plan of union, on the following basis: All local clubs to become chapters of the American Society and to be recognized as such; conditions of membership to be settled by conference. The report was accepted and it was ordered that the Committee be appointed as recommended, and the President appointed as such Committee Messrs. R. E. McMath, J. A. Seddon, and Robert Moore.

Engineers' Club of Kansas City.—The programme for the meetings of this Club for the present season includes the reading and discussion of the following papers:

October 7, Tests and Observations on Building Stones, by J. A. L. Waddell and W. D. Jenkins.

November 4, general discussion on Sewerage Systems.

December 2, Snow Plows, by F. E. Sickels.

December 4, Annual Meeting of the Club.

September 7, a regular meeting was held at Wallula, Kan., by invitation of Mr. H. A. Keefer. It was voted to appoint a committee to confer with a committee of the American Society of Civil Engineers, and similar local committees with reference to a closer affiliation among the various engineering societies. Resolutions of respect to E. J. Remillon, a member lately deceased, were passed.

Papers were ready by A. G. Glasgow on Water Gas, and by H. A. Keefer, on the Early Manufacture of Iron.

After a brief discussion of the papers, the Club was entertained at lunch by Mr. and Mrs. Keefer.

New England Railroad Club.—The September meeting of this Club consisted of a dinner and reception, which was held September 11 at the United States Hotel in Boston. A large number of members of the Club and invited guests were present, most of them accompanied by ladies. After the dinner a number of speeches were made.

NOTES AND NEWS.

A New Naval Dry-Dock.—The great new dry-dock at the Norfolk Navy Yard was opened September 19, the steamer *Yantic* being the first vessel docked.

The new dock is 530 ft. over all, and will take a vessel of 430 ft. in length of keel, 26 ft. 6 in. draft, and in width will take anything now afloat. The depth of water at the entrance to the dock at high water will be 26 ft. 6 in., and at low water will be 23 ft. 8 in., the rise and fall of the tide at the Navy Yard being 2 ft. 10 in. The average depth of the Southern Branch of the Elizabeth River, which forms the approach to the new dock, is about 35 ft. at high water, and this will allow the largest ships of the Navy to come up at any time. The site of the dock, which is near the southern end of the yard, was chosen on account of the width of the river at the point, and its close proximity to the various shops of the yard. The axis of the dock lies about northwest by southeast, and it is protected on three sides from heavy gales, which makes it possible to dock a vessel in the roughest weather. The dock when full holds about 8,000,000 gallons of water, and at the official inspection of the dock it was emptied in the short time of 1 hour 5 minutes 26 seconds. The pumps are two in number, and of the centrifugal order, built by the Southwark Foundry & Machine Company of Philadelphia. They have an average capacity each of about 52,000 gallons per minute. The contract for the building of the dock specified that these pumps should have a capacity of 40,000 gallons, but the test shows them to be largely above this figure.

The foundation of the dock is piling, over which, to the depth of 3 ft., is a solid bed of concrete. Above the concrete floor the dock is of wood, and 1,000,000 ft. of Georgia heart pine and almost as much other timber was used in its construction. Where any of the timber is exposed to the salt water it was creosoted to prevent it from the destroying attacks of the toredo worm. The caisson which closes the mouth of the dock is an

iron structure ribbed and riveted, and is worked with water ballast. There are eight feeding valves and culverts through it, and by them the dock has by actual test been flooded to a depth of 25 ft. in 55 minutes. All of the bilge blocks are operated from the top of the dock. The sides of the dock, which are constructed with steps which have 8 in. rise and 10 in. tread, makes shoring easy.

This dock was built for the Government by J. E. Simpson & Company; its total cost was about $495,700, and the time occupied in building it was 22 months.

Collapse of a Locomotive Water Tank.—The *Zeitschrift der Lokomotivführer* records the collapse of a locomotive water tank, which is noteworthy in several respects. The tanks were located at both sides of the boiler, measured about 18 ft. by 2½ ft., by 1½ ft., and held, together, about 123 cubic feet. They were connected by a 4-in. pipe, and the water level was shown by a float and suitable index. The walls of the tank were stiffened by angle irons and flat braces riveted to the inside. The engine, having just come in from a run, was to be housed, and as the tanks were nearly empty a water-supply pipe was coupled on, and the right-hand tank filled. The right-hand injector was still feeding while steam from the boiler, which was at a pressure of about two atmospheres, was being blown into the left-hand tank. This lasted about three minutes, when suddenly this tank collapsed with a loud noise similar to that produced by a hammer-blow against an empty tank. The force of the collapse was such as to bend or break all the angles and to bend the braces to one side. The tank-plates above and below the angle irons were torn and the top and bottom plates forced outward. One of several plates, about 7 in. wide and 0.7 in. thick, by means of which the tank was bolted to the engine frame, was wholly broken off. The extent of the damage points to the fact that the partial vacuum produced by the inflow of steam to the tank must have been considerable, and can be explained by the circumstance that an appreciable quantity of cold water overflowed from the right-hand tank, which had become full, into the one on the left, in which there was only a small quantity of water, not sufficient to condense the steam in it. The covers on the tanks were practically air-tight, having become battered down by the constant concussion while on the road, and being furthermore held in place by springs. Entrance of air was, therefore, impossible, there being no special provision for this, as in the engines of more recent build.

Electric Light for a Penny.—One of the latest novelties in the application of electricity has recently been fitted to the cars of an English railway line. The apparatus is conveniently placed just above the head of the passenger and is contained in a small box about 5 in. long and 3 in. wide, in which is a five-candle-power light. To obtain the desired illumination a penny is dropped in a slot in the top of the box, and by a subsequent pressure of a knob the current is turned on, giving a light that will last half an hour, at the end of which it is automatically extinguished.

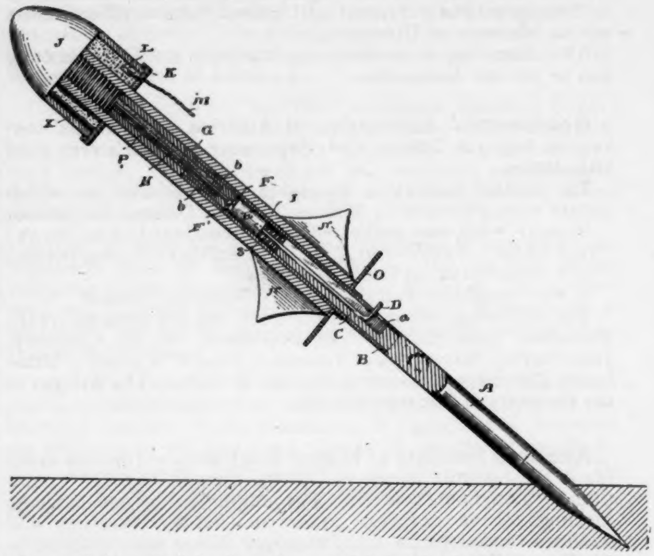
A second push-button affords a means of putting out the light at the will of the passenger. Should the light be desired for a longer time than half an hour, a penny dropped in at the end of that interval will suffice. Should the instrument be out of order the penny drops right through and comes out at the bottom of the box, so that it can be recovered, and the same result happens in the case of any coin other than a penny. Each carriage is fitted with an accumulator for supplying the electricity. The invention has been found to add greatly to the comfort of passengers, and is very much superior to the lamp formerly in use, screens being supplied to prevent the light interfering with those who do not care to use it.

Indian Railroad Accidents.—At the end of the last quarter of 1888 there were 14,456 miles of railroad open in this country, and the total number of passengers killed was only 13, and of those injured 45 in a train mileage run of 12,588,692 miles. In addition to the above, 47 servants of the companies were killed, and 151 injured, while of others, such as trespassers and suicides, there were 60 killed and 26 injured. Besides these, 11 persons were killed and 44 injured in yards, workshops, etc., and 138 persons died in the carriages or at stations from causes unconnected with the working of trains. These figures naturally show an increase over the average of the same quarter for the previous five years, but if the extra number of miles of lines open are taken into consideration, both the number of fatal accidents and of injuries were less in proportion. There was a large increase in the number of accidents on the Bengal-Nagpur, the Oudh & Rohilkund, the Southern Mahratta and the Nizam's railroads, while there was a decrease on the Northwestern, the Eastern Bengal, and the Great Indian Peninsula Railroads. The worst accident occurred on the Tirhoot State Railroad, owing to a collision between a mixed train and some wagons on the Motihari goods shed line, in which three coolies were killed on the spot, and four seriously injured. This accident was due to the carelessness of the station staff, some of whom were prosecuted and imprisoned.—*Indian Engineer.*

The Emmens Torpedo Gun.—The accompanying illustration shows a torpedo and torpedo gun, which is the subject of United States patent No. 409,943, recently granted to Stephen H. Emmens, of London, England. The device is thus described by the inventor:

"The figure represents an elevation of a torpedo-gun and a bird-torpedo, partly in longitudinal section, illustrating this invention.

"The firing mechanism, which especially distinguishes the present weapon, comprises a wooden stock *A*, fitting into and supporting a metallic tube *B*, and axially perforated and slotted at its front end to accommodate within said tube a rod *C*, which is bent at right angles at its rear end to form a trigger *D*, that projects outward through a bayonet-joint slot *a* in the stock *A* and tube *B*. The front end of said rod *C* is fixed in a piston *E*, which carries a firing-pin *F*, and between said piston and the front end of the stock *A* is a spiral spring *s*; hence, when the



trigger *D* is pulled back and turned into the holding-notch of the bayonet-joint slot *a* said spring *s* is compressed, and when the trigger is released the spring urges forward the piston *E*, with its firing-pin *F* to explode the propelling-charge *P*. This is contained within a short gun-cartridge shell or powder-tube *G*, which fits into the front end of said tube *B* and is coupled thereto by a pair of bayonet-joints *b*. Preferably the powder-tube, as it is hereinafter termed, is provided with a primer-recess *F'* in its breech end and with an axial ignition-tube *H*, extending forward from said primer-recess to the front of the propelling charge. The latter may be of any suitable explosive. The ignition-tube is filled with gunpowder, and the recess *F'* is provided with a suitable percussion-primer. When the latter is exploded by the firing-pin *F*, a sheet of flame is produced within the tube *H*, which ignites the propelling-charge *P* at its front end, so as to insure its perfect combustion and an effective discharge of the weapon.

"The bird-torpedo comprises a tube *I* fitting closely over said tubes *G* and *B* and plugged at its forward end by the screw-stem of a conoidal torpedo-head *J*. In an external annular charge-space immediately behind the head and around said tube *I* cartridges of emmensite or other high explosive are arranged side by side to form the high-explosive charge *X*. By using cartridges of different lengths the size of the high-explosive charge may be varied to any required extent. These cartridges are held in position by a collar *K* and a cylindrical jacket *L*, and they are fired by a time-fuse *M*. The rear end of the torpedo-tube *I* is provided with three equidistant wings *N*. An annular screen *O* is fitted to the tube *B* immediately in front of the trigger *D*, to protect the hand of the person discharging the weapon from any escape of heated gases between said tubes *B* and *I*.

"The figure shows the weapon planted in the ground for firing; but it will be understood that any other mode of mounting may be employed—as, for example, the stock may be clamped in a holding-tube on an ordinary swivel-stand or gunwale attachment."

A Novel Wall.—Having been called on for a design for a parapet wall to be built to enclose a garden in a large bastion of the old fort in Bheer, Hyderabad, Deccan, the following design suggested itself to meet the conditions of the case: The bastion wall is about 70 ft. in height; some 10 or 15 ft. of the upper portion having fallen down, it was repaired in a "kutcha" manner, so that it was untrustworthy to build on, and as the rampart, forming a fine evening promenade for the Taluqdar and his officials of an evening, could not well be encroached on, it became necessary to build something on the very edge. A wire railing in such a position was not considered suited to the case, so the following was designed: At intervals of nearly 6 ft., upright standards of T-iron, with heads of the T's outward are fixed by pronged feet into the ground at 2 ft. apart in pairs, the gauge being maintained by ties, as shown in sketches. Corrugated sheet-iron is then sprung in between the T standards, and the interior space filled with rammed earth. The top of the wall is planted with creepers or flowers, along which a rill of water flows in a split bamboo. The applications of this principle are numerous, such as revetting the banks of canals,

Fig. 1

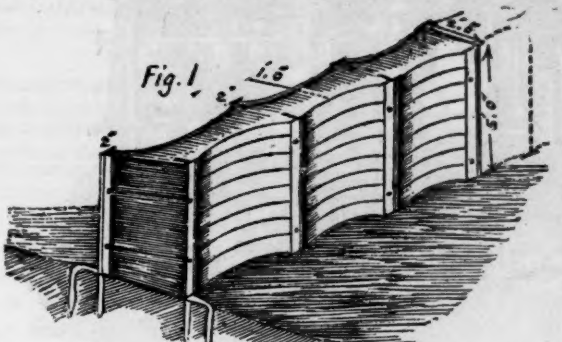
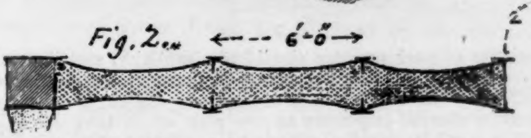


Fig. 2



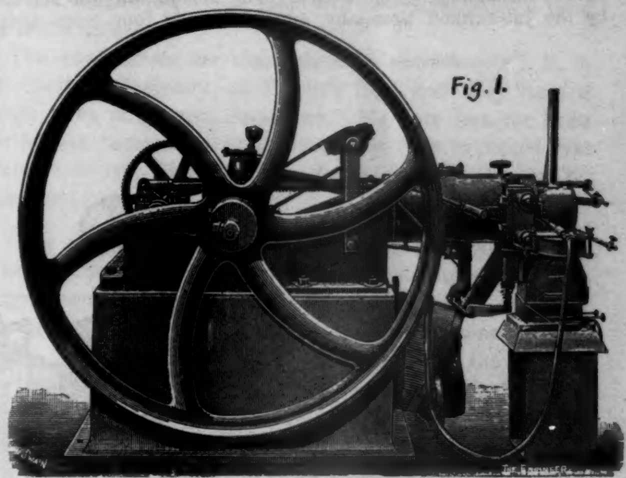
making piers of bridges, lofty signal towers or pillars for elevating wire ropes for crossing ferry-boats over streams, in which case the pillars can be filled with sand.—*Indian Engineering.*

The Knight Petroleum Engine.—The accompanying engravings show a new oil engine invented by J. H. Knight, of Barfield, Farnham, England. It is a horizontal engine, burning the vapor of paraffine oil in the cylinder. The ½ H. P. shown in the engraving has a 4-in. cylinder and an 8-in. stroke. The vaporizing chamber is at the end of the cylinder, which is closed by a steel plate about ½ in. thick, and to which are attached plates somewhat like the ribs of a Gurney's stove projecting into the vaporizing chamber. The latter and part of the cylinder and lighting slide are shown in the sectional view, fig. 2. In this *A* is the cylinder; *B* the vaporizer; *C* the steel plate closing the cylinder, to which are fixed the copper radiating plates; *D* the slide containing the wire; *P* the platinum wire; *E* the lamp; *F* the blow-pipe, and *H* the lamp-container.

Under the vaporizing chamber is a paraffine heating stove for preliminary heating. This heats the chamber to a considerable temperature, and when it is hot enough, which is in 10 to 15 minutes, a small quantity of oil is pumped into the chamber by a small pump—not shown in the engraving. Some of this is immediately vaporized, and on the fly-wheel being turned by hand it is sucked into the cylinder, fired, and motion given to the moving parts. The air and oil enter together by the vertical pipe at the after end of the engine. The heating lamp is extinguished when the engine has got well to work. Vapor of paraffine oil is more difficult to ignite than gas or bensoline vapor. The igniting slide, which is of very small dimensions, contains in a hole a spiral of platinum wire. This is exposed to the flame of a paraffine oil lamp, a high temperature flame of the blow-pipe kind, the air blast for which is made by the bellows fixed on the after end of the bed-plate under the cylinder. At the proper moment, the platinum wire, which is kept at a white heat, is by the motion of a cam drawn into communication with the compressed charge of vapor and air. The slide, although intermittently exposed at one end to the heat of the blow-pipe, wears remarkably well. In one engine, which has been in daily use for a year and a half, the slide has not been refaced or scraped up during that time. The soot and oil vapor appear to act as an excellent lubricant. The oil is pumped into the chamber by a diminutive force-pump worked by the engine. It is on the right-hand side of the cylinder.

The engine is on the three-cycle system, the same as the Griffin and Beck gas engines. The great advantage of this system for oil engines is, that as the exhaust is completely cleared away from the cylinder the charge of vapor and oil is more readily ignited. The governor acts in a twofold manner, first by stopping the supply of oil to the vaporizing chamber,

Fig. 1.



and by preventing the valve connecting the cylinder and vaporizing chamber from opening, so that an explosion is missed. The cylinder is water-jacketed, the water circulating as in gas engines. No oil is required in the cylinder; a small quantity of the vapor condenses at each stroke and acts as a lubricant. The slide requires a small quantity of oil. The ½ H. P. engine runs 30 revolutions per minute, and gives 0.8 to 0.95 H. P. on the brake, according to the quality of oil used. If a suitable oil is

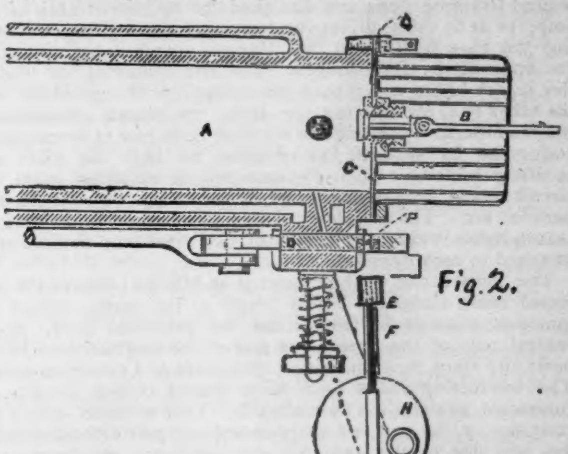


Fig. 2.

used, a brake horse-power requires, we are informed, one-fifth of a gallon of oil per hour. The igniting lamp burns about a pint and a half in the day. The oil used is ordinary paraffine or kerosene oil, such as is used in all parts of the world for illuminating purposes, and which does not give off an inflammable vapor at a low temperature.—*London Engineer.*

Petroleum in Beluchistan.—The Kattan Petroleum Works have now passed beyond the experimental stage. An agreement has been definitely entered into to supply for the works at the Khojak Tunnel about 3,250,000 gallons of the oil. The wells, which are 42 miles from the railway, have been connected with Babar Kuch on the Sind-Peshin line by an excellent road. The water supply has been seen to, and house accommodation is increasing. The saving to the State from the use of the petroleum on the Khojak works alone will, it is estimated, be enough to cover all the cost of the Kattan experiments and leave a balance. There is no reason to anticipate that the benefits of the apparently inexhaustible supply should end here. In a country like Beluchistan, where every stick of wood is worth its weight in silver, the demand for the new fuel must be great,

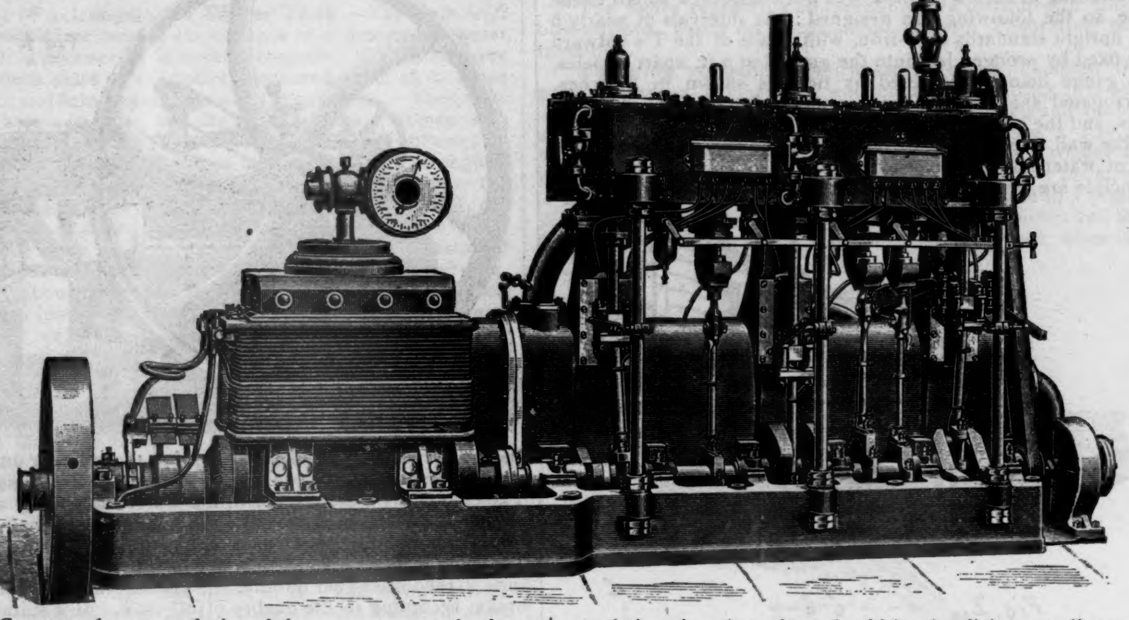
and the destruction of the forests, which recently was going on at an alarming rate, will be put a stop to. It is intended to replace the expensive and wasteful method of camel carriage by a pipe-line from the wells along the Babar Kuch road, which will fully develop the new industry.

Electric-Light Installation on the Armor-clad Cruiser "Admiral Nakimoff."—This is the first Russian armor-clad lighted throughout by electricity. The installation was set up by the Jablochkoff Company, and consists of four compound-wound Gramme dynamos, designed for an output each of 140 ampères at 65 volts, driven by four separate engines, and feeding 320 glow-lamps and two Mangin search-lights, placed at the ends of the fore-bridges. The two dynamos for feeding the search-lights are placed amidships on the gun-deck, and the other two, for lighting the decks, are placed amidships on the main-deck. The engines working each pair of dynamos are connected by separate steam-pipes to both the main and auxiliary boilers. Each dynamo can be switched on to any circuit at will, and each pair of dynamos can be connected in parallel arc. The switching of any dynamo on to the deck or search-lights is done by means of two three-way commutators attached to each dynamo.

The construction of the cruiser is as follows: Above the protected deck, along the whole length of the vessel, extend the gun and main-decks, and under the protected deck, in the central part of the vessel, are placed the engines, and in the bows and stern the ammunition magazines and provision-stores. The conducting-mains form three closed double circuits, all connected to the main switchboard. Two of these double circuits supply the gun and main-decks, one pair extending along the port side of the gun-deck, descending at the bows to the main-deck, thence led aft along the whole length of the port side of the main-deck, and ascending at the stern to the gun-deck, where the respective conductors join, and thus form each a complete circuit. The second pair of conductors travel along a parallel path, but on the starboard side of the vessel. The third pair of conductors supply the engine-rooms, stoke-holes, and magazines. Owing to the uneven distribution of the lamps along the decks, the conductors are not of uniform section throughout, one half being 20 sq. mm. (0.31 sq. in.), and the other half 40 sq. mm. (0.62 sq. in.). The corresponding main-conductors of the port and starboard circuit on the gun and main-decks can be connected together at the fore and after part of the ship by means of switchboards, to which they are connected by supplementary conductors. The lights on the fore and after orlop-decks are regulated by auxiliary switchboards, so that they can be fed direct from the dynamos, or, in cases of need, from 150 accumulators on each deck.

The advantages claimed by the inventor for this system of lighting on war-ships are, that the laying of the conductors on the gun and main-decks in an annular path prevents the extinction of any lamp, in the case of a single injury to one of the conductors by an enemy's shell; as main conductors will be still connected at the ends to the dynamo, and the circuit will not be broken; also by joining the circuits at the fore and aft switchboards, even the total severing of one pair of the conductors leading to the main switchboard would not cause the extinction of any lamp; and thirdly, that the orlop-decks, where the chief engines of war are situated, being supplied either by accumulators or the dynamos, their illumination can be cut off only by the destruction of the decks themselves.

A Ship-Dynamo and Engine.—The accompanying illustration shows a new high-speed engine, which has been designed by Messrs. John I. Thornycroft & Company, Chiswick, England, for driving dynamos on board ship. The special characteristics of such engines should be simplicity, steadiness, and efficiency, and this engine combines these in a high degree of excellence. As it is a miniature marine engine, it will be welcomed by marine engineers as one with which they are already familiar in all its details. The engine illustrated is of the triple expansion type, and is fitted complete with its own condenser and pumps. With 150 lbs. boiler pressure and 28-in. vacuum, it indicates 50 H. P., the speed being 350 revolutions per minute. Special care has been bestowed on the perfect balancing of all the parts, and the engine is provided with a heavy fly-wheel. Suitable liners are fitted to the connecting-rod, and crank brasses to allow of easy and accurate readjustment. The engine is characterized by that excellency of design and workmanship which are the results of long experience. The first of these engines was built for the electric light installation on board the steam yacht *Thetis*, belonging to Mr. Donaldson.—*Industries.*



Iron Industry in China.—Hon. Charles Denby, Minister of the United States to China, writes from Pekin under date of May 29: "I have the honor to inclose an Imperial decree commenting on the late proposal of the Viceroy of Canton to develop the iron industry in the To-Kuang. In order to foster this important industry he has abolished the inland duties of iron and the prohibition against its export. He now proposes to investigate by a commission the subject of abolishing the heavy duty now levied on furnaces. Such a plan put into force for three years would not involve a large diminution of the revenue, but would greatly benefit the iron producers by doing away with illegal fees. He proposes, also, the creation of a joint-stock company to work the furnaces, and with foreign machinery. It would seem that the mind of this distinguished man had undergone a change. He now, while still materially seeking to retain to his own people the benefits of industrial enterprises, favors the extensive use of foreign methods in building railroads and establishing electric lights and foundries. I do not doubt that the next process in his mental development, will lead him to the only correct conclusion. That is to say, that foreign talent and honesty and will power are indispensable to the successful introduction of foreign improvements. I have long advocated the idea that the successful work of Sir Robert Hart, Inspector-General of Imperial Customs, furnishes the model for future enterprise in China. When China puts at the head of her railroad system a distinguished foreigner, and when she does this also in a department of banking, a magnificent improvement will be inaugurated which, in its results, will astonish the world."